EDITORIAL

GENERAL EXPENSE will command the Army that will bring about peace in Europe.

AN announcement of interest to all readers of WESTERN ENGINEERING will be found in this issue on page 4 of the advertising section.

STANDARDIZATION is a good thing even for technical magazines. It is more convenient both for readers and publishers to have the new volume begin with the new year. For this reason, the January issue of WESTERN ENGINEERING will be No. 1 of Volume VII, and this volume will run through the year.

ONE of the many reasons why bonds of irrigation districts have not been especially attractive to investors is that they are not accepted as security for state deposits, notwithstanding the fact that both the engineering and financial features of such projects are scrutinized carefully by state officials before any securities are placed upon the market. So the state officials have been saying in effect to the general public: "This is a good investment for you, but our employer has no confidence in it." This anomalous condition is now to be corrected and irrigation bonds will be placed on a more solid footing.

GEOLOGICAL SURVEY reports and maps are regarded as models of accuracy by the practising engineer and investigator in civil life. Nevertheless, the scientists of the Survey are human and are therefore prone to err occasionally. Mr. L. J. Pepperberg in this issue has called attention to a serious discrepancy between a Geological Survey report and the accompanying map. In this particular instance the map and the text disagree in some essential particulars, and since many engineers have formed the habit of using the map without the text, as a means of reducing the bulk of impedimenta incident to field work, the consequence of such a discrepancy may be imagined. Since constructive criticism is far more beneficial than casual praise, we feel that our readers, as well as the officials of the Geological Survey, will profit through the attention drawn to this matter. We have become accustomed to such high standards of accuracy in all the work of the Geological Survey that it is something of a shock to be brought to a realization that perfection is rarely if ever attainable, even by Uncle Sam. In bringing this matter to our notice, Mr. Pepperberg's original intention was that his own name should not appear in the matter, but in order that the various statements might be definitely connected with the man who was actually on the ground, he was persuaded to write a signed article.

THE celebration of Electrical Prosperity Week, accompanied by the slogan of "Do it electrically," reminds us of a new and somewhat original application within the electrical field. At a recent dinner in honor of the mechanical and electrical engineers for the Panama-Pacific International Exposition, the chair of each speaker was connected to an electric circuit under the control of the toastmaster. At the touch of a button the speaker arose, perhaps not voluntarily, but with a great deal of alacrity, nevertheless. The fifteen-minute limit was automatically enforced by the same means, and the sudden projection of the next speaker upon the field of speech making was a delicate yet convincing hint to the offender that it was time to sit down. Whether an after-dinner speaker may be regarded as a public utility and thus subject to regulation, is perhaps a debatable question, and ordinarily we do not believe that anyone, even a toastmaster, should take the law in his own hands, so to speak. Nevertheless, we have reason to know to our cost that thus far no method, scientific or otherwise, has been devised that had any marked effect upon the length of after-dinner speeches. We therefore feel inclined to register our approval of the action taken by the knights of the kilowatt, but this of course is not to serve as a precedent in case high-tension transmission should be applied to suppress the things that we like to do ourselves.

PORK-BARREL politics is the besetting weakness of the American form of government. This detestable custom is not confined to Washington, but extends in one form or another down the line through state, county, and city affairs as well. By way of example: Bids were opened some time ago by the Los Angeles City Harbor Commission for the construction of a warehouse at the municipal wharf. The lowest bid was $117,138.15, submitted by a responsible firm of local contractors. The engineer's estimate was $140,000, which would indicate that any individual acting for himself or for a group of stockholders in a corporation would have at once accepted the bid. On the suggestion that such action be taken, however, a storm of opposition arose and it was actually proposed that the city should go ahead and do the work by day labor. Fortunately for the tax-payers of Los Angeles, wiser counsel prevailed, and after some two weeks' deliberation the low bidders were awarded the contract. Such action as was originally proposed is all too frequent and the most unfortunate part of all is that in many cases representatives of the people are actually supported by their constituents for so doing. It is easier to get an appropriation of a million dollars for the construction of a white marble post-office in Podunk

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Centre, or some other thriving interior community of a few hundred souls, than to provide adequate funds for the national defence. We hope that the day may come when the public in general may be educated up to the belief that what is bad for them as individuals is equally bad for them as citizens of a nation.

ELECTRICAL Prosperity Week is being celebrated throughout the United States. For some reasons, it would hardly seem necessary to direct attention to the existence of electrical prosperity, or better, prosperity induced by electricity. "Do it electrically," is the slogan that has traversed the world, and a little thought will show to what an enormous extent things are now being done electrically, better and cheaper than they have ever been done by any other means. Achievements such as the radio-telegraph, and now the radio-telephone, to say nothing of the transcontinental telephone system, are of such stupendous magnitude, that they for the time being completely overshadow what to our way of thinking are even greater achievements, the use of electricity in the home. The greatest good to the greatest number is what really counts, and where may a more striking exemplification of this crowning achievement be found than in the lightening of domestic drudgery made possible through the agency of electricity. Electrical devices for the home are far from being classed as luxuries. Intensive manufacturing methods coupled to constant experimentation have produced the wealth of electrical labor-saving devices which are fast finding a way into every home in the land. In some cases, first cost is still high, as in the case of the electric oven, electric heaters and a few other devices. This, however, is a condition that is no more than temporary, and the time is not so far distant when practically all cooking and heating in the homes of the moderately well-to-do will be done better, more cheaply, and with a minimum of effort by electricity. Here in the West, the electric service corporations are conducting searching investigations to determine how rates may be fixed at a point that will permit electric cooking and heating for moderate-sized dwellings at a cost that will compare favorably with that for coal or gas. Improvement in both apparatus and cost of power go hand in hand toward the day when "Do it electrically" will be succeeded by "How else could it be done?" The power of the future can be nothing other than, not merely electricity, but hydro-electricity. The hydro-carbons, whether liquids or solid are a wasting resource. Their supply is definitely limited. There is no replacement by Nature. With water power, it is another story. Every year come the snow and rains, replenishing the catchment basins with liquid potential foot-pounds of energy, in readiness to be diverted to the service of mankind. The failure of the supply of coal, petroleum, and wood is not a problem that will affect the present generation, or several to come. That does not make it any the less inevitable, however, and it is reassuring to know that electrical development is more than keeping pace with the trend of events so that when the time comes, it will be prepared to fulfill its destiny.

PRECISION is a jewel, but unless based upon a foundation of fact becomes only a spurious imitation. The method of the recently graduated fledgling engineer who solemnly paces off the diameter of a circle and then calculates the circumference to six decimal places, is similar to the practice now in vogue for gauging the contents of oil-tanks in California. It has been customary for many years for gaugers to measure the depth of oil in a tank with a steel tape graduated to eighths of an inch. After reading the tape, the content of the tank is taken from a tabulated gauge sheet calculated in terms of thousandths of a barrel. Then the gauger reads the temperature in degrees Fahrenheit and arrives at his temperature correction by consulting another set of tables which were calculated for oil of totally different composition and physical properties. This method, perhaps, might be construed as good enough during the boom days when it was the 'oil game' rather than the 'oil industry.' In the present state of the art, however, this method is totally out of keeping with the scientific strides that have taken place in petroleum production. Individual producers would undoubtedly like to know accurately how much oil they were delivering to the marketing companies. The expense of conducting an independent investigation to determine the actual coefficient of expansion would be almost prohibitory, and in fact this should be a function of one of the scientific bureaus of the United States government. The United States Bureau of Mines has undertaken to solve the problem and in this issue is published the first authoritative report of the results of this investigation. The most significant fact deduced from the experiments is that a fair correction for temperature is 1% of the volume for every 25° variation in temperature Fahrenheit, whereas the tables now in use are calculated on the basis of 1% for every 20° variation. This is particularly important to California producers for the reason that on account of the greater ease in pumping hot oil, practically all pipe-line shipments are made and paid for when the oil has a temperature considerably above the standard of 60° Fahrenheit. Probably 100° would be nearer the average shipping temperature. For example, suppose that a company ships 100,000 barrels of oil a month at a temperature of 100°. By the present method of computation, the quantity at standard temperature, or 60°, would shrink to 98,000 barrels. The figure, using the correct coefficient of expansion as indicated by the Bureau of Mines, would be 98,400 barrels. This difference of 400 barrels is perhaps not great in this particular instance, but at 40 cents per barrel would amount to $160, or about one-fifth of a cent per barrel variation for the entire shipment. In the aggregate, however, considering the large quantity of oil handled by refiners and marketers, a tidy little sum would be realized through the difference in their favor every month, the difference always being against the producers for the reason above stated, that practically all oil shipments are made at a high temperature. It would appear that this matter would be well worth investigating by some of the associations of oil producers.

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REVIEW OF THE MONTH

IN a few days the Panama-Pacific Exposition will have become no more than a delightful memory. The attendance during the last few days has indicated that the total will exceed 18,000,000 before the Exposition closes its doors at midnight on December 4. That the Exposition Company as a business organization will have several hundred thousand dollars on hand, after paying all expenses, is a tribute to the wonderful executive ability of President Charles C. Moore and his associates. This gratifying state of financial independence is unique in the annals of expositions and makes a record to which the citizens of California and San Francisco may well point with pride. What disposition will be made of the surplus funds is as yet undetermined. It seems not unlikely at present that they will be diverted toward the construction of some civic improvement project that will leave a lasting monument to perpetuate the glories of San Francisco, 1915.

AS is usually the case, the American tendency to overdo is coming to the fore as the day for the closing of the Exposition draws near. The unreasoning sentimentalist is proposing all sorts of fantastic schemes, ranging from the continuance of the Exposition for any period to the proposal to take the Tower of Jewels and move it bodily to the summit of one of the nearby hills, for what purpose we know not. The situation seems comparable to that which frequently occurs when a host urges his guest to stay a little longer after he has made all preparations for departure. The continuance of the Exposition on any pretext would result in an anti-climax and have an effect the opposite to the one most desired. Welcome the coming and speed the parting guest, and the guest who departs with regrets for the end of a delightful entertainment is the best exemplification of the highest type of hospitality.

WE are inclined to doubt the practicability of the suggested preservation of the fair buildings. Lath and stucco is not the most permanent form of construction, especially on buildings of such large superficial area. As examples of engineering skill and architectural beauty in the design and construction of buildings for temporary use, they are beyond cavil. Whether structural changes and alterations could be made that would make the preservation possible is a question for the department of works at the Exposition to decide. Whether they could be converted to any useful purpose after preservation is still another question. The greater part of the site for the Exposition is a part of a military reservation, and as such is not especially adapted for use as a play-ground. The Exposition opened on time; let it also close on time amid universal regrets.

THE field of activity of the United States Reclamation Service is ordinarily understood to exclude the drainage of swamp and overflow lands. Nevertheless, works of this kind are features of the Klamath project. Lost river, which was the principal tributary of Tule lake, has been diverted into the Klamath river. The lake in consequence is rapidly receding. It is estimated that within two or three years the lake will be dry, thus making ready for entry an area of some 35,000 acres. In the meantime the 3000 acres which have already been drained are to be leased for agricultural purposes.

THIS is a buyer's market, especially within the line of engineering construction work. Bids were recently opened for the construction of a sewer in Corvallis, Oregon, for which the engineer's estimate was about $1000. A great many bids were received from contractors, some of whom had their principal place of business 75 miles away. One bidder, whose headquarters was 40 miles from Corvallis, underbid the local men and was awarded the contract. While it is true that this is no time for reckless expenditure, nevertheless municipalities and others contemplating engineering construction work of all kinds can get more for their money now than they will a year or so hence. This is offered as a suggestion worth serious consideration.

PETROLEUM production for the month of October is on a par with previous months at a rate of about 250,000 barrels per day. Shipments, however, continue to increase. In September the excess of shipments over production was 15,000 barrels per day, while in October this had increased to 30,000 barrels. These figures are based upon statistical reports as to the volume of shipments. The so-called 'shut-in' production, however, is difficult to estimate, but is usually arbitrarily placed at about 18,000 barrels. Thus for the first time in many years, shipments have exceeded even potential production. There is, however, a certain amount of seasonal buying in the oil market, and October is one of the months during which many retailers lay in a stock for the winter. It also should not be forgotten that since existing stocks consist of nearly 60,000,000 barrels, an excess of shipments over production of a million barrels per month might continue for some time without having any marked effect upon prices. Nevertheless, prices are rising in most of the eastern and mid-continent fields, while the Standard Oil Company has placed in effect a

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small increase in prices offered in California. Here, at least, is one case where the stringency in the money market is of positive benefit to the existing oil producers through the inability of promoters to obtain capital with which to 'wildcat' undeveloped ground. If the drilling of new wells may be curtailed for a while, a depletion of stocks and consequently better prices should come as a matter of logical sequence. If, on the other hand, operating companies now in the field, and the promoters who would like to get into the field, should take advantage of this condition as an excuse for inaugurating a drilling or stock-selling campaign, it will not take long before the state of affairs in the oil industry from the producer's standpoint will be worse than ever.

WHEN the law establishing state control over protective measures for the preservation of California oilfields went into effect, apprehension was expressed by a number of operators that this was only another attempt on the part of the State to regulate everything and everybody. This feeling, we are glad to note, has almost entirely disappeared. This is due primarily to the judicious selection of the director and his staff. Mr. R. P. McLaughlin and his assistants are far from amateurs in the petroleum field. They have all had years of practical experience, and through the exercise of tactful consideration for those with whom they came in contact, have created a feeling of confidence in the minds of the operators that the purpose of the State was to assist rather than hinder production of oil. The new department does not interfere with an individual in his drilling methods, or even with his methods for shutting off water; all that it does insist upon is that water shall be shut off satisfactorily before continuing drilling operations, in order that the possibility of injury not only to his own but his neighbor's well also may be entirely eliminated. For old work, the department is helping to shut off the water as best it can in order that the field may be preserved from destruction due to infiltrating water. The arbitration clause in the law offers redress and a means of preventing injustice to any individual operator or company. Little, if any, opposition has been displayed toward the other requirements of the law, as all recognize the great collective advantage that will accrue to the operators through the gathering of accurate logs and production statistics. The oil men of California have outgrown the doctrine of 'I shall do as I please with my own regardless of the effect it may have upon what is my neighbor's' and are appreciating the value of collective effort and co-operation, as well as that the prosperity of the individual depends on the welfare of the industry.

WHILE the relations of oil-men with the California state government are amicable, those with the Federal government are, to say the least, a bit strained. The Department of Justice steadily continues to file suits against companies operating on unpatented land within the withdrawn area. Recently the Navy department has disturbed the minds of operators on lands within the so-called naval reserves in the Buena Vista and Elk Hills districts by posting notices on most of the land, claiming ownership thereof and warning against further "exploration." Agents for the Department, however, have stated that the companies now operating will be undisturbed pending the outcome of the various suits now in the courts. Meanwhile the companies operating on all unpatented land are awakening to the gravity of the situation. The newly-formed Oil Industry Association is gaining members from all classes of oil-operators, whether they are affected directly by the withdrawal orders or not. Steps are being taken to enlist the aid of the California delegation as well as other members of Congress, and efforts are to be made to obtain remedial legislation at the coming session.

THERE is no general agreement thus far as to the form that such legislation should take. At present, even those companies that were actually drilling for oil on the fateful twenty-seventh of September, 1909, and which continued operations until oil was discovered, cannot be sure of remaining in possession of the property they are now occupying. Furthermore, in the filing of suits, the Government has shown a tendency to exaggerate slight violations of the letter of the law, such as the transfer of locators' interests, as well as the temporary suspension of drilling operations due to lack of funds. On the other hand, oil-men operating on withdrawn land have seemed to assume that they, and not the people as a whole, were the owners of the public domain. Had they recognized six years ago that a leasing system was inevitable, it would not have been difficult to put a leasing law through Congress which would have been favorable to the development of the industry and would protect any real rights of locators. Such a law might have provided that the company operating on an unpatented quarter-section should have a preferred right to lease the land under conditions regarding line-drilling, spacing of wells, and shutting off water that would have insured real conservation. Exploration permits for a reasonable length of time might be issued and, if oil were found, the land leased on similar terms. It might have been possible to eliminate the royalty feature in the leases providing merely for fees for expenses of administration. In any case, a small royalty could have been fixed. Instead, the operators have demanded that patents be granted without delay, even to companies that have acted in defiance of the spirit as well as the letter of the law, until the impression has gone forth that all claims to California oil-land should be denied in the interests of justice and of conservation. It is to be hoped that a delegation may be sent to Washington which will be able to show Congress that such is not universally the case. Of the 100,000,000 barrels output of oil in California last year, probably about 15,000,000 barrels was produced by companies operating on unpatented land, the title to which is doubtful. To dispossess these companies would have a serious effect not only upon the oil industry but also upon the State as a whole. Furthermore, while it might be according to law, it would not be according to justice.

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The Coefficient of Expansion of California Crude Oils and Distillates*

By A. S. CROSSFIELD†

The calculation of the specific gravity and volume of an oil at standard temperatures from values determined at temperatures differing from the standard requires a knowledge of the coefficient of expansion of the oil. To acquire this information, the Bureau of Mines has carried out an investigation on the coefficient of expansion of samples of crude oils and distillates from the California fields. It is seldom that two oils of similar physical characteristics have the same coefficient of expansion,

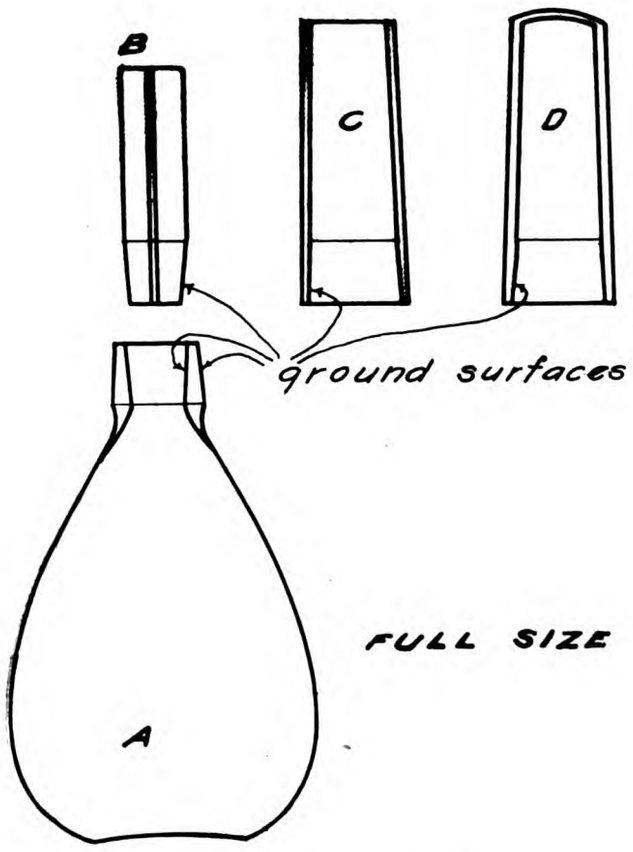

FIG. IX. SPECIFIC GRAVITY BOTTLE.

the difference depending on the inherent composition of the oil. For exact work the coefficient of expansion of each oil should be determined. However, the difference between commercial crudes is very small and for practical purposes negligible. In practice it is sufficient to employ the values connected with the changes in specific gravity and temperature.

Twenty-one composite samples from eighteen California fields, were made up from a large number of individual samples, the sources of which are shown in the table. It is believed that a good representation of typical California oils has thereby been secured.

SAMPLE NO. 1523, NEWHALL FIELD

Individual sample number.	Location. S.	T.	R.	Lease.	Well number.
255	7	3	15	Elsmire (Union)	2
256	7	3	15	" "	20
257	7	3	16	Alpine (Santa Ana)	1
258	7	3	16	Santa Ana	3
260	6	3	15	Kellerman	..
262	16	3	16	Wiley	6
263	1 and 2	3	17	C. S. O. W...1, 2, 4, 5, 6, 7, 12, 13, 15, 18, 19, 21, 22, 23, 24, 25, 27, 28, 29, Star	

SAMPLE NO. 1524, PIRU FIELD

264	3 and 4		18	Union 13, 14, 15, 16, 17, 18	
265		3	18	Union Oil Co	56
266		3	18	" " "	33
267		3	18	" " "	21
268		3	18	" " "	58
269		3	18	" " "	15
270		3	18	" " "	29
271		3	18	" " "	34
272	8	4	18	Modella... 1, 4, 5, 6, 12, 16, 17, 24	
273	8	4	18	" 7, 19, 21, 22, 28, 29	
274	12	4	19	Sunset.....2, 4, 6, 7, 9	
275	12	4	19	Harris 1, 2	
276	13	4	19	Fortuna.....3, 4, 5, 6, 8, 14, 16, 18	

SAMPLE NO. 1525, BARDSDALE FIELD

277	12	3	19	Bronson	1
278	12	3	20	Robertson	7
279	12	3	20	" 2, 12, 13	
281	12	3	20	Bookhart	5

SAMPLE NO. 1526, SESPE FIELD

283	6	4	20	My Dream	..
284	6	4	20	Kentuck .....7 wells	
285	6	4	19	Central	2
286	6	4	19	Los Angeles 4, 6, 7	
287	32	5	19	Hog's Head 1, 2	
288	33	4	19	Consolidated Elk	1

SAMPLE NO. 1527, SANTA PAULA FIELD

289	14	4	21	Empire	1
290	13	4	21	" 7, 11	
291	18	4	20	"	3
292	17	4	21	Capital Crude	..
293	18	4	21	" "	..
294	18	4	21	" "	..
296	13	5	22	West Lake	..

SAMPLE NO. 1528, SUMMERLAND FIELD

301				Churchill .....8 wells	
302				Becker .....7 wells	
303				Wilson .....7 wells	
304				J. B. Treadwell Consolidated..	20
305				Wakham (Sunset)	6
307				Fort Duquesne	11

*Presented at the first annual meeting of the American Petroleum Society, San Francisco, October 1915, and published by permission of the United States Bureau of Mines.

†506 Custom House, San Francisco.

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Individual sample number.	Location. S.	T.	R.	Lease.	Well number.
				Sample No. 1529, Santa Maria Field	
312	Rancho Puenta de la Laguna			Kaiser	4
313	"	"	"	"	5
314	"	"	"	Rice Ranch	2
315	"	"	"	Hobbs	7
316	"	"	"	"	3
317	"	"	"	Fox	4
319	"	"	"	"	8
320	"	"	"	"	1
321	"	"	"	Pinal	8
322	"	"	"	"	2
323	"	"	"	"	12
324	"	"	"	"	15
326	Rancho Todos Santos			Hartnell	1
327	"	"	"	"	4
329	"	"	"	Santa Maria Oil & Gas.	8
330	Rancho Puenta de la Laguna			Folsom	8
331	"	"	"	"	1
332	"	"	"	"	6
333	"	"	"	"	5
334	"	"	"	"	3
335	Rancho Todos Santos			California Coast or Escolla	5
336	Rancho Los Alamos			New Love (Union)	5
337	"	"	"	" " "	1
338	"	"	"	Graciosa	5
339	"	"	"	"	11
340	"	"	"	Western Union	10
341	"	"	"	" "	26
342	"	"	"	" "	14
513	"	"	"	New Love (Union)	12
514	"	"	"	" " "	2
515	"	"	"	" " "	15
516	"	"	"	" " "	13
517	"	"	"	" " "	9
519	"	"	"	" " "	1
520	"	"	"	" " "	20
522	"	"	"	" " "	22
524	"	"	"	Teresa Bell	2
525	"	"	"	New Penn	3
				Sample No. 1530, Coalinga Field	
410	12	20	15	Coalinga Mohawk	1
612	12	20	14	Shawmut	5
613	32	19	15	Empire	1
614	1	20	14	Zier	6
615	31	19	15	Confidence	6
616	31	19	15	Commercial Petroleum	12
617	31	19	15	Main State	5
618	31	19	15	Commercial Petroleum	5
619	12	20	14	Shawmut	4
620	1	20	14	Zier	12
621	31	19	15	K. T. O.	3
622	12	20	14	Shawmut	6
623	7	20	15	Arica	6
624	7	20	15	"	4
625	7	20	15	Coalinga Pacific	1
626	8	20	15	Security	1
627	18	20	15	Nevada Petroleum	1
628	8	20	15	California Coalinga	1
629	7	20	15	Section 7	4
630	25	20	14	K. T. O.	15
631	25	20	14	"	35
632	25	20	14	"	20
633	25	20	14	"	25
634	6	21	15	Pacific States Top Sand	1
636	6	21	15	Silver Tip	1
637	6	21	15	" "	2
638	30	20	15	Nevada Petroleum	1
639	6	21	15	De Lux	1
640	28	19	15	Stockholders	5
641	28	19	15	Standard	46
642	28	19	15	"	76
643	28	19	15	"	60
644	28	19	15	"	49
645	28	19	15	"	77
646	28	19	15	"	6
647	21	19	15	California Oil Fields (Ltd.)	1
648	27	19	15	" " " "	43
649	27	19	15	" " " "	25
650	27	19	15	" " " "	26
651	27	19	15	" " " "	53
652	27	19	15	" " " "	51
653	34	19	15	" " " "	7
654	26	19	15	" " " "	5
655	34	19	15	" " " "	5
656	27	19	15	" " " "	46
657	26	19	15	" " " "	2
658	27	19	15	" " " "	2
664	34	19	15	" " " "	4
665	2	20	15	W. K. Oil Co.	4
666	34	19	15	California Oil Fields (Ltd.)	16
667	2	20	15	Turner Oil Co.	1
				Sample No. 1531, Midway Field	
586	31	31	23	Hawaiian	1
587	26	31	22	Manchurian Midway	1
588	23	31	22	Dome	1
589	12	31	22	American Oil Fields (Ltd.)	1
590	31	31	23	Hawaiian	2
591	14	31	22	Bear Creek	3
593	25	31	22	C. C. M. O. (Santa Fe)	1
594	6	32	23	United Oil	2
598	36	31	22	American Oil Fields (Ltd.)	79
600	4	32	23	La Belle	1
601	32	31	23	California Midway	1
602	23	31	22	Rock	2
604	25	11	23	Western Minerals	8
605	35	11	23	" "	11
				Sample No. 1532, Sunset Field	
449	1	11	24	Monte Cristo	12
451	35	32	23	Webster	1
563	21	11	23	Union	4
567	32	11	23	Pacific Midway	1
568	6	11	23	Maricopa National	1
569	1	11	24	K. T. O.	25
570	1	11	24	"	27
571	1	11	24	"	1
572	1	11	24	Monte Cristo	8
573	1	11	24	" "	4
574	1	11	24	" "	1
575	2	11	24	Ruby	8
576	2	11	24	"	10
577	25	12	24	Lake View	1
579	26	32	23	Nevada Midway	1
580	30	32	23	Standard	3
581	30	32	23	"	4
582	30	32	23	"	8
583	20	32	24	"	1
584	15	31	22	Globe Exploration Co.	1
592	30	31	23	Mays	1
595	6	32	23	United Oil	5
596	6	32	23	" "	6
597	31	31	23	C. C. M. O. (Santa Fe)	3
599	31	31	23	Mammoth	1

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Individual sample number.	Location. S.	T.	R.	Lease.	Well number.
606	14	32	23	Standard	2
607	14	32	23	"	1
608	24	32	23	"	9
609	26	32	23	Nevada Midway	2
610	26	32	23	North American Con.	5
611	23	32	23	Babcock Petrol	7
				SAMPLE NO. 1533, KERN RIVER FIELD	
126	30	28	28	Hawkeye Associated	1, 2
127	30	28	28	Nevada County	8, 11, 14
128	29	28	28	Linda Vista	1-5
129	29	28	28	Mecca	5
130	29	28	28	Perseus	2
131	29	28	28	Columbian	3
132	29	28	28	Continental	4
133	29	28	28	Sacramento	8, 9
134	28	28	28	Comet	3, 6, 7
135	31	28	28	Gross Meyer	1-7
136	31	28	28	Vesta	1-9
137	31	28	28	Sterling	20-2
138	31	28	28	Sovereign	16
139	31	28	28	Peerless	38
140	31	28	28	"	54
141	32	28	28	Claremont	14
142	32	28	28	West Shore	21
143	32	28	28	" "	11
144	33	28	28	Imperial	87-88, 92-94
145	33	28	28	"	12, 13, 17, 50
146	33	28	28	"	51, 52, 55, 56
147	33	28	28	Thirty-Three	51
148	5	29	28	Monte Cristo	12, 17, 39
149	5	29	28	" "	21
150	5	29	28	Del Rey	2-6
151	5	29	28	Asso. San Joaquin	13-16 17-22
152	4	29	28	Four	10
153	4	29	28	Asso. of Central Point	1-4, 7-9, 21, 24, 33
154	4	28	28	Knob Hill	15
155	4	29	28	Alma	5
156	4	29	28	Asso. Red Bank	7, 11, 13
157	4	29	28	Petroleum Development	22
158	3	29	28	K. T. O.	53, 61
159	3	29	28	"	155, 166, 167
160	3	29	28	"	121
161	3	29	28	"	18
162	3	29	28	"	8
163	3	29	28	Petroleum Development	11
164	2	29	28	Petroleum Development (Santa Fe)	4, 6
165	9	29	28	Junction	2
				SAMPLE NO. 1534, COALINGA FIELD	
6	22	19	15	A. O. National	5
9	21	19	15	California Oil Fields (Ltd.)	3
11	27	19	15	" " " "	28
13	27	19	15	" " " "	19, 21
15	26	19	15	" " " "	2
18	34	19	15	" " " "	9,10
22	20	19	15	Coalinga	4
26	28	19	15	Hanford	8
27	28	19	15	Standard	9
44	6	20	15	Esperanza	4
49	1	20	14	Zier	6
51	1	20	14	R. H. Herron	3
52	1	20	14	Pennsylvania Coalinga	1
54	12	20	14	Shawmut	3
63	14	20	14	Coalinga Petroleum	3
67	23	20	14	Coalinga Western	1, 2
69	23	20	14	" "	4
70	23	20	14	" "	5
71	23	20	14	St. Paul-Fresno	3
74	24	20	14	Inca	4
76	24	20	14	Wabash	3
372	6	21	15	Lucile	3
373	36	20	14	Associated	9g
374	36	20	14	"	9a
375	30	20	15	American Petroleum	2
376	30	20	15	" "	6
377	25	20	14	K. T. & O.	1, 4
378	25	20	14	"	11
379	26	20	14	Cawdor Develop.	2
380	24	20	14	Marengo	1-3, 22-26
381	24	20	14	"	26
382	24	20	14	Traders	12, 13, 32-34
383	24	20	14	Inca	12
384	24	20	14	Morse	3
385	19	20	15	American Petroleum	1
386	18	20	15	" "	5
387	18	20	15	" "	8
388	12	20	14	Pilot	2
389	12	20	14	"	4
390	12	20	14	Seneca	4
391	12	20	14	Ward	3
392	12	20	14	"	5
393	28	19	15	Standard	22
394	28	19	15	"	19
395	28	19	15	"	68
397	28	19	15	"	54
399	22	19	15	Caribou	17
400	22	19	15	"	14
402	22	19	15	Record	3
403	14	19	15	California Oil Fields, Ltd.	5
404	10	19	15	" " " "	2
405	10	19	15	" " " "	3
406	10	19	15	" " " "	1
407	2	19	15	W. M. Graham	5
				SAMPLE NO. 1535, MCKITTRICK FIELD	
84	11	7	21	Clara Foltz	1
85	11	7	21	S. F. McKittrick	3-8
86	14	30	21	S. P. R. R., Reward, K. T. & O.	3
87	13	30	21	Southern Pacific	23
88	13	30	21	" "	17
90	13	30	21	Kern River	1
91	18	30	22	McKittrick	2, 5, 6
92	13	30	21	Pacific Crude	1
93	19	30	22	Silver Bow	1
94	19	30	22	Shamrock	51
95	19	30	22	"	1, 2, 5, 6
96	20	30	22	S. P. R. R.	10
97	20	30	22	"	6
98	29	30	22	Dabney	14
99	29	30	22	"	11
475	19	30	22	Silver Bow	3
476	13	30	21	Associated	34
478	11	30	21	San Francisco-McKittrick	12
479	11	30	21	East Puente	6
480	11	30	21	C. J. No. 2	1
482	18	30	22	Cousins	4
368	36	29	20	Section 6 Oil Co.	4, 5, 7
				SAMPLE NO. 1536, MIDWAY FIELD	
100	8	32	23	Oriental	1
101	8	32	23	Chancellor & Canfield	1
102	16	32	23	A. B. Lockwood	1
103	25	32	23	Sunset Coast	1
105	26	32	23	Mascot	2
106	26	32	23	"	4
107	25	32	23	Croesus	1
108	25	32	23	Paraffine	1

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Individual sample number.	Location. S.	T.	R.	Lease.	Well number.
454	32	32	24	Monte Cristo	4
456	25	32	23	Elkhorn	1
457	25	32	23	Tight Wad	1
458	25	32	23	Rico	1
459	25	32	23	Section Twenty-five	2
460	26	32	23	Mascot	6
461	26	32	23	"	12
462	26	32	23	"	8
463	26	32	23	Mount Diablo	1
464	24	32	23	Standard	1
465	24	32	23	"	5
466	23	32	23	Griffith Crude	1
468	22	32	23	Burks	3
469	22	32	23	Fairbanks	2
470	14	32	23	Leland & Dyer	1
471	16	32	23	Midland	2
472	8	32	23	C. & C. Midway	1
473	8	32	23	Midway of Oregon	1
474	31	31	23	William Matson	1
				SAMPLE NO. 1537, SUNSET FIELD	
109	34	12	24	Reynolds	1
110	34	12	24	"	2
111	35	12	24	Sunset Road	3
112	35	12	24	Pacific	2
113	2	11	24	Sunset Monarch	4
114	2	11	24	Monarch	2
115	2	11	24	California Diamond	1
116	2	11	24	Arcola	2
117	2	11	24	United Crude	2
118	2	11	24	Adeline	5
119	1	11	24	Maricopa	2
120	12	11	24	New Center	4
121	13	11	24	Alameda	1
122	13	11	24	Sunset Diamond	2
123	18	11	23	Sedalia California	5-7
124	20	11	23	Navaho	..
446	1	11	24	Loma Vista	2
447	1	11	24	Gate City	1
448	1	11	24	Monte Cristo	9
449	1	11	24	" "	12
450	2	11	24	Ruby	1
451	35	12	24	Webster	1
452	34	12	24	Tannehill	8
453	33	12	24	Union	2
				SAMPLE NO. 3052, LOS ANGELES CITY FIELD	
166				Horton & Curtis	2
167				C. C. Harris	4-5
168				" "	19-20
169				Giegerich	1, 5, 22
170				Doran, Brown & Price	2, 3
171				Tyler	7
172				"	1-4
173				T. C. Harris	11, 12
174				" "	14, 25
175				Daggers & Fletcher	1, 3, 4, 5, 6, 8, 9, 10, 12
176				Palin	14-19
177				Davis & Harrison	4
178				C. C. Harris	18 or 2
179				T. A. Clampitt	6
180				" "	22
181				Los Angeles R. R.	4
182				Richard Green	12-15
183				I. W. Shirley	5, 13-19
184				Whittier Consolidated	6
185				McCray	5, 2, 3, 1-7, 2, 10-13
186				Koford	7, 8
187				Woolner	21-27

Individual sample number.	Location. S.	T.	R.	Lease.	Well number.
				SAMPLE NO. 3053, LA BREA AND SALT LAKE FIELDS	
188				Hancock Ranch	139
189				" "	6
190				" "	37
191				" "	49
192				" "	3
193				" "	11
194				Union (Pitcher & Garbutt)	3
195				" " "	4
196				Gilmore	5
197				Pacific Light & Power Co.	3
198				" " " "	9
199				Clark	1-15
201				Rancho La Brea	7, 8
203				Salt Lake (Hancock)	324
204				" " "	346, 347, 349
				SAMPLE NO. 3054, FULLERTON FIELD	
205	9	3	9	Columbia	17
206	9	3	9	"	22
207	9	3	9	Fullerton	2
208	8	3	9	Santa Fe	1
209	8	3	9	" "	24
210	8	3	9	" "	26
211	8	3	9	" "	49
212	8	3	9	" "	42
213	8	3	9	Fullerton Consolidated	16
214	8	3	9	Union	33
215	8	3	9	"	35
				SAMPLE NO. 3055, BREA CANYON FIELD	
217	6	3	9	Union	28
218	1	3	10	"	15
219	1	3	10	"	21
220	1	3	10	Brea Canyon	1, 7
221	1	3	10	" "	8
222	1	3	10	" "	12
223	1	3	10	" "	18
224	1	3	10	" "	19
225	2	3	10	Menges	2
				SAMPLE NO. 3056, PUENTE HILLS FIELD	
226	35	2	10	Puente	52
227	35	2	10	"	21
228	35	2	10	"	45
229	35	2	10	"	26
230	34	2	10	"	32
231	34	2	10	"	60
232	34	2	10	"	70
233	34	2	10	"	4
234	34	2	10	"	16
				SAMPLE NO. 3057, WHITTIER FIELD	
235	26	2	11	Murphy	21
236	26	2	11	"	5
237	26	2	11	"	8
238	26	2	11	"	14
239	23	2	11	Central	50
240	23	2	11	"	1
241	23	2	11	"	4
242	22	2	11	"	8
243	22	2	11	"	2
244	22	2	11	Fidelity	4
245	22	2	11	"	5
246	22	2	11	Turner	6
247	22	2	11	"	8
248	22	2	11	Home	6
249	22	2	11	"	18
250	22	2	11	"	14
251	22	2	11	Whittier Crude	8
252	21	2	11	" "	10

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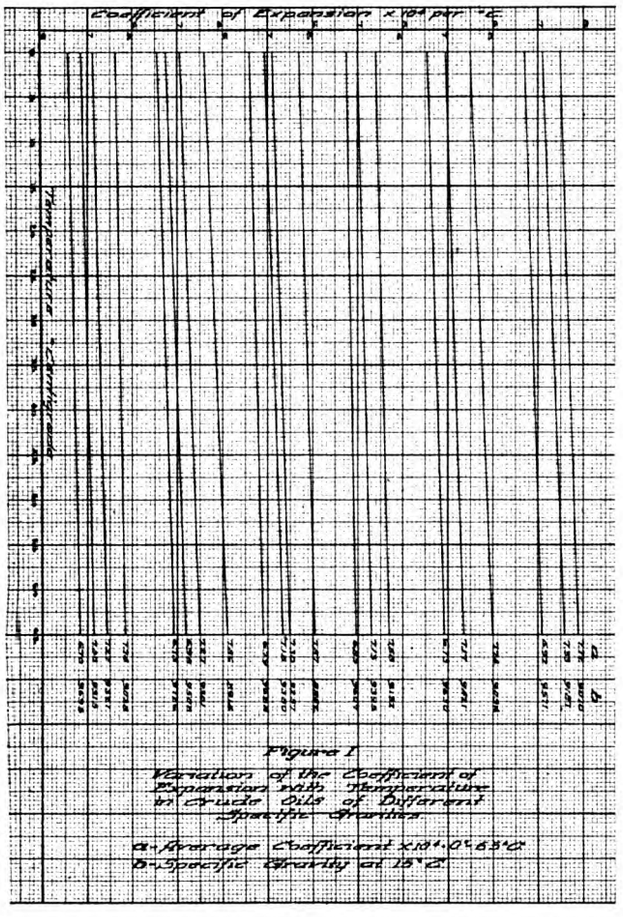
Apparatus Used and Method of Operation. The apparatus consisted of four parts as shown in Fig. IX. *a* is the usual form of specific gravity bottle of 25 to 30 c.c. capacity. *b* is the capillary stopper with a ground joint to fit inside *a*. *c* is an overflow-tube ground to fit over the neck of *a*, about 0.5 cm. greater in length than *b*. *d* is a cap of approximately the same length and similarly ground to fit *a* when *c* is removed. With this form of bottle the specific gravity of oil of practically any consistency and at any convenient temperature can be determined.


Coefficient of Expansion x 10⁴ per °C.
Temperature - Centigrade
a
b
Figure I
Variation of the Coefficient of Expansion with Temperature in Crude Oils of Different Specific Gravities
a-Average Coefficient x10⁴ 0°-65°C.
b-Specific Gravity at 15°C.

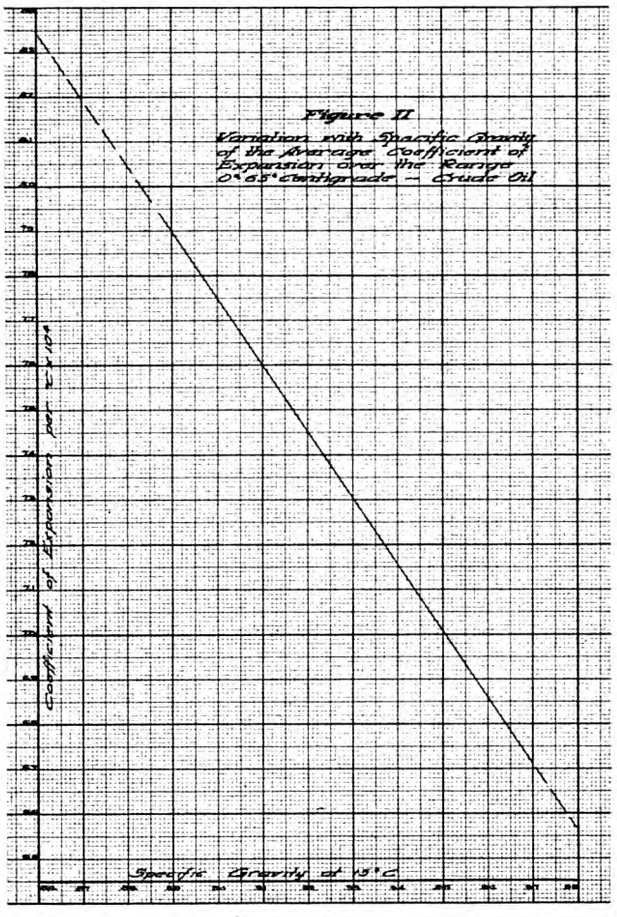


Figure II
Variation with Specific Gravity of the Average Coefficient of Expansion, over the Range 0°-65° Centigrade - Crude Oil
Coefficient of Expansion per °C. x 10⁴
Specific Gravity at 15°C.

The procedure in the manipulation of the bottle is as follows. With heavy oils at room temperatures it is difficult to force the capillary stopper into place without risk of bursting the bottle. This danger is eliminated by the use of the overflow-tube *c*. The oil is heated to such a temperature that after the bottle is filled, the stopper can be easily inserted. The overflow-tube is then placed in position and also filled with oil. The bottle is then cooled slightly below the temperature required for the test and the oil in the overflow tube is drawn into the bottle through the capillary, the bottle thereby being completely filled. The tube is then removed, the temperature of the oil is raised to and maintained at the test temperature until the oil ceases to flow out through the capillary. All weighings should be made at room temperature. This necessitates allowing the bottle to stand until this temperature is reached. If the temperature of test has been considerably below room temperature, the subsequent warming is accompanied by expansion of the oil and overflow through the capillary and down the sides of the bottle. With the tube *c* again in place, the overflow is retained and there is no resulting loss of the sample or contamination of the balance-pans. If the test has been made at elevated temperatures, there is the danger of loss through volatilization during the period of cooling to room temperature. With the cap *d* in place, substituted for tube *c* the system is closed and the danger of loss is removed. It was found advisable to close the bottle with cap *d* in all tests made above 30°C.

The volume of the bottle at 15°C. was determined with water and at 50°C. with mercury. From these volumes the coefficient of expansion of the glass was determined, and from it the volumes of the bottle at the desired temperatures were calculated. All temperatures were controlled to within 0.02°C. by means of a thermometer accurately calibrated to 0.1°C. A lens was used to estimate the values less than 0.1°C.

Basis of Calculations. The usual definition of the coefficient of expansion is the increase in the volume of the unit volume at 0°C., when heated 1°C. However, in the oil industry the standard temperature is 15°C., and in this investigation it has seemed advisable to base all calculations on unit volume, at 15°C. The difference in the values obtained on each basis is slight and is negligible for all practical purposes.

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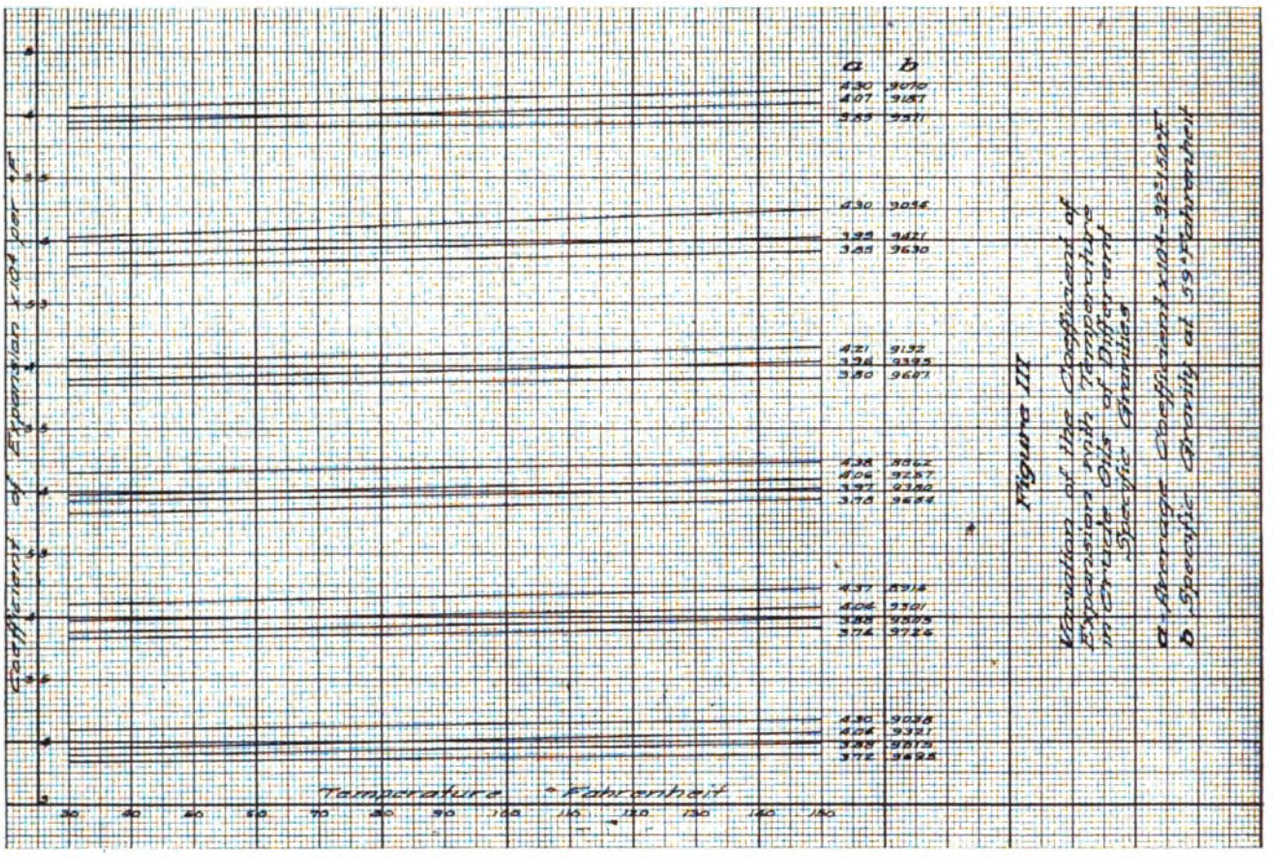

Figure III

Variation with Specific Gravity of the Average Coefficient of Expansion over the Range 32-150° Fahrenheit - Crude Oil

a - Specific Gravity at 59° Fahrenheit

b - Specific Gravity at 60° Fahrenheit

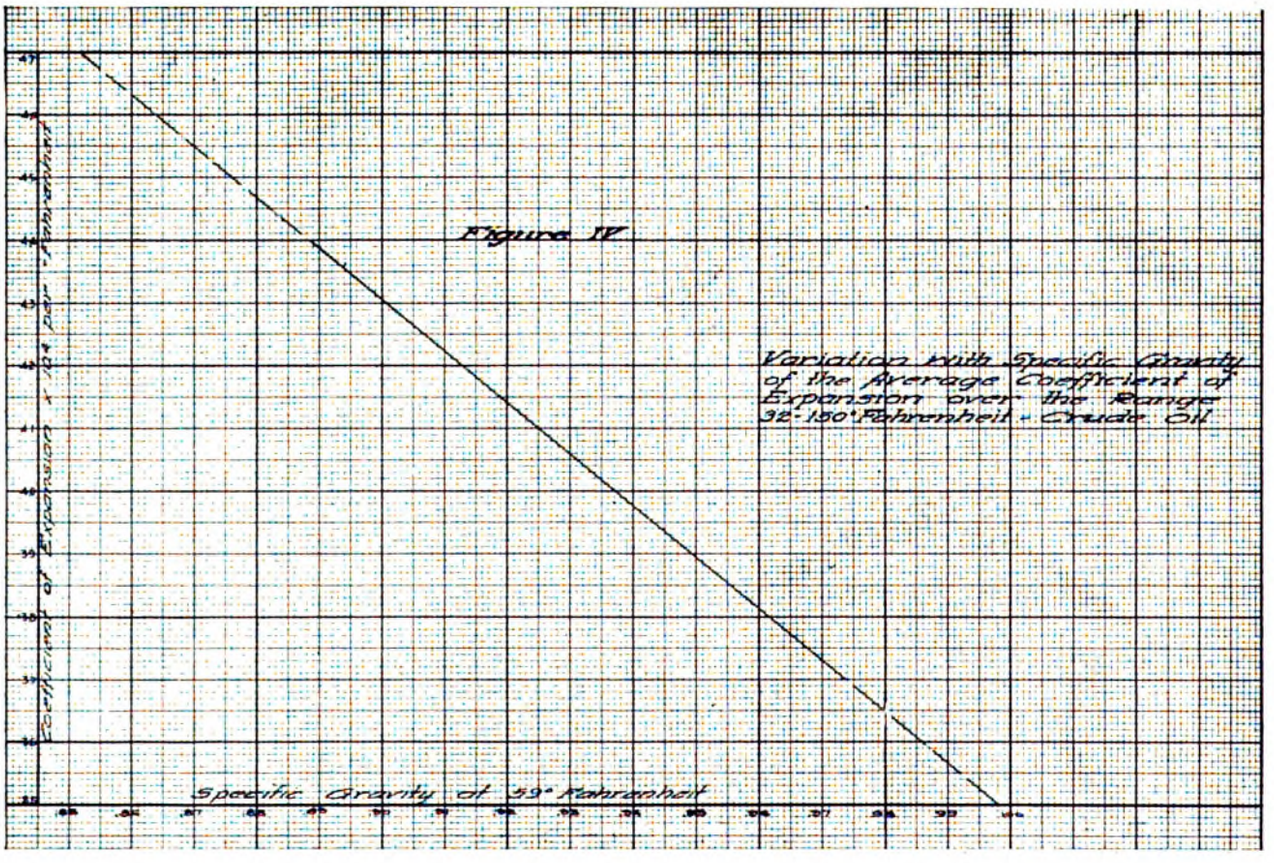
Figure IV
Variation with Specific Gravity of the Average Coefficient of Expansion over the Range 32-150° Fahrenheit - Crude Oil
Specific Gravity at 59° Fahrenheit
Coefficient of Expansion per degree Fahr. x 10⁶

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By the method outlined above the weight of the known volume of oil (the volume of the bottle) was determined. From these two values the specific volume was calculated. The coefficient of expansion was then derived from the following formula:

$$X_{t-15^\circ}=\frac{\text{Specific volume}_t - \text{specific volume}_{15^\circ}}{(t-15^\circ)\ \text{Specific volume}_{15^\circ}}$$

where X_{t-15° is the coefficient of expansion over the temperature range t–15°, specific volume$_t$ and specific volume$_{15}$, the specific volumes at t and 15°, respectively.

A temperature range of 0°–65°C. was adopted as that usually prevailing in the oil industry in the measurement of large volumes of oil.

Results. The value of the coefficients on the different samples at different temperatures is shown in Table 1. The designation of the different columns is

TABLE NO. 1

Coefficient of Expansion of California Crude Oils.

Sample No.	Field	Spec. Grav. at 15° C.	Coefficient of Expansion x 10^4 over ranges t-15°: Temperature, t. 5	20	25	35.15	45.2	55	65	Mean coef. 0-65°
1523	Newhall	.9321	7.08	7.08	7.18	7.26	7.32	7.36	7.40	7.27
1524	Piru	.9132	7.40	7.31	7.49	7.48	7.65	7.67	7.73	7.58
1525	Bardsdale	.9036	7.68	7.41	7.50	7.76	7.84	7.86	7.85	7.74
1526	Sespe	.8914	7.76		7.58	7.79	7.85	8.15	8.10	7.86
1527	Santa Paula	.9054	7.69		7.60	7.86	7.88	7.93	7.97	7.74
1528	Summerland	.9654	6.66		6.75	6.80	6.84	6.88	6.93	6.79
1529	Santa Maria	.9070	7.44	7.71	7.71	7.61	7.72	7.83	7.96	7.72
1530	Coalinga	.9395	7.14	6.96	7.05	7.09	7.19	7.26	7.31	7.13
1531	Midway	.9301	7.25	7.07	7.16	7.26	7.36	7.40	7.46	7.27
1532	Sunset	.9421	7.06	6.98	7.16	7.11	7.18	7.27	7.33	7.17
1533	Kern	.9695	6.59	6.59	6.69	6.74	6.75	6.81	6.84	6.70
1534	Coalinga	.9515	6.66	7.04	6.95	6.99	7.03	7.09	7.16	7.00
1535	McKittrick	.9607	6.82	6.72	6.82	6.82	6.88	6.94	6.97	6.85
1536	Midway	.9571	6.80	6.89	6.89	6.89	6.94	7.01	7.04	6.92
1537	Sunset	.9726	6.71	6.61	6.61	6.71	6.83	6.83	6.87	6.73
3052	Los Angeles	.9630	6.55	6.74	6.64	6.64	6.85	6.89	6.93	6.75
3053	La Brea	.9505	6.84	6.84	6.84	6.98	7.08	7.13	7.20	6.98
3054	Fullerton	.9187	7.17	7.17	7.35	7.30	7.45	7.49	7.75	7.33
3055	Brea Canyon	.9257	7.22	7.04	7.22	7.31	7.20	7.52	7.57	7.30
3056	Puente Hills	.8862	7.80	7.80	7.89	7.71	7.88	8.15	8.01	7.87
3057	Whittier	.9380	6.94	7.13	7.13	7.22	7.30	7.28	7.35	7.15

Approximate average equals - - - - - - - - - - - - - - - 7.20 per°

Equals - - - - 4.00per°F

TABLE NO. 2

Coefficient of Expansion of California Distillates.

Distillate No.	Spec. Grav. at 15° C.	Coefficient of Expansion x 10^4 over ranges t-15°: Temperature, t. 5	25	35.15	45.2	55	65	Mean coef. 0-65°
1	.7246	13.33	11.59	11.97	12.12	12.54	-----	11.85
2	.7492	11.01	11.16	11.38	11.36	11.53	-----	11.28
3	.7737	9.21	11.53	10.56	10.91	11.10	-----	10.62
4	.7961	9.55	9.39	9.72	9.78	10.03	-----	9.70
5	.8245	8.90	8.49	9.15	9.23	9.34	9.45	9.14
6	.8471	8.47	8.30	8.56	8.64	8.79	8.91	8.60
7	.8704	8.09	8.01	8.12	8.24	8.38	8.46	8.14
8	.8879	7.64	7.81	7.84	7.91	8.01	8.10	7.85
9	.9235	7.20	7.39	7.38	7.43	7.50	7.54	7.37
10	.9543	6.58	6.78	6.87	6.92	6.99	7.02	6.81
Fuel Oil Residuum	.9562	6.76	6.80	6.85	6.92	6.95	6.98	6.80

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self-explanatory. All temperatures are expressed in degrees Centigrade.

The above values of the coefficient of expansion for each oil were plotted as a function of the temperature and are shown in Fig. I. It will be seen from an examination of these curves that the coefficient is a straight-line function of the temperature and that it slowly increases as the temperature increases. From these curves the mean coefficient for each sample over the range 0°–65°, namely, the value of the coefficient at a temperature of 32.5° was obtained and plotted as a function of the corresponding specific gravity; Fig. II. This curve approximates a straight line, which shows that the coefficient is close to a direct function of the specific gravity as stated in the introduction. The dotted portions of the line are extensions of the determined line, for which no data was at hand. Figures III and IV are the same as I and II, expressed in terms of Fahrenheit degrees.

Each of the composite samples was then distilled without cracking, cuts being made approximating commercial practice, and the distillates of like specific gravities from each sample were combined. A typical fuel-oil residuum was made up from the different fractions and the asphalt residue in the proportions which were indicated by the results of the distillation analyses. The coefficient of expansion was determined on each cut and on the fuel residuum as for the crude oils, except that the specific volumes of the four lightest cuts were determined by means of the Westphal balance. The values obtained are shown in Table 2. It will be seen that the values of the coefficient determined for the fuel residuum are almost identical with those obtained for the last distillation-cut, and for all practical purposes the values are the same. In the application of the curves, the temperature-variation curve for the heaviest of the distillates is to be used in the determination of the coefficient for all fuel oil

TABLE No. 3

Degrees Baumé Corresponding to Specific Gravities at 60°F. (15.56°C.)

$\frac{D^{15.56}_{15.56}}{}$	0	1	2	3	4	5	6	7	8	9
0.60	103.333	102.945	102.558	102.172	101.788	101.405	101.023	100.642	100.263	99.885 3
.61	99.508	99.133	98.758	98.385	98.013	97.642	97.273	96.904	96.537	96.171
.62	95.806	95.443	95.080	94.719	94.359	94.000	93.642	93.285	92.930	92.576
.63	92.222	91.870	91.519	91.169	90.820	90.472	90.126	89.780	89.436	89.092
.64	88.750	88.409	88.068	87.729	87.391	87.054	86.718	86.383	86.049	85.716
.65	85.385	85.054	84.724	84.395	84.067	83.741	83.415	83.090	82.766	82.443
.66	82.121	81.800	81.480	81.161	80.843	80.526	80.210	79.895	79.581	79.268
.67	78.955	78.644	78.333	78.024	77.715	77.407	77.101	76.795	76.490	76.186
.68	75.882	75.580	75.279	74.978	74.678	74.380	74.082	73.785	73.488	73.193
.69	72.899	72.605	72.312	72.020	71.729	71.439	71.149	70.861	70.573	70.286
.70	70.000	69.715	69.430	69.146	68.864	68.582	68.300	68.020	67.740	67.461
.71	67.183	66.906	66.629	66.354	66.078	65.804	65.531	65.258	64.986	64.715
.72	64.444	64.175	63.906	63.638	63.370	63.103	62.837	62.572	62.308	62.044
.73	61.781	61.518	61.257	60.996	60.736	60.476	60.217	59.959	59.702	59.445
.74	59.189	58.934	58.679	58.425	58.172	57.919	57.668	57.416	57.166	56.916
.75	56.667	56.418	56.170	55.923	55.676	55.430	55.185	54.941	54.697	54.453
.76	54.210	53.968	53.727	53.486	53.246	53.007	52.768	52.529	52.292	52.055
.77	51.818	51.582	51.347	51.113	50.879	50.645	50.412	50.180	49.949	49.718
.78	49.487	49.257	49.028	48.799	48.571	48.344	48.117	47.891	47.665	47.440
.79	47.215	46.991	46.768	46.545	46.322	46.101	45.879	45.659	45.439	45.219
.80	45.000	44.781	44.564	44.346	44.129	43.913	43.697	43.482	43.267	43.053
.81	42.840	42.626	42.414	42.202	41.990	41.779	41.569	41.359	41.149	40.940
.82	40.732	40.524	40.316	40.109	39.903	39.697	39.492	39.287	39.082	38.878
.83	38.675	38.472	38.269	38.067	37.866	37.665	37.464	37.264	37.064	36.866
.84	36.667	36.469	36.271	36.074	35.877	35.680	35.485	35.289	35.094	34.900
.85	34.706	34.512	34.319	34.127	33.934	33.743	33.551	33.361	33.170	32.980
.86	32.791	32.602	32.413	32.225	32.037	31.850	31.663	31.476	31.290	31.105
.87	30.920	30.735	30.550	30.366	30.183	30.000	29.817	29.635	29.453	29.272
.88	29.091	28.910	28.730	28.550	28.371	28.192	28.014	27.835	27.658	27.480
.89	27.303	27.127	26.951	26.775	26.600	26.425	26.250	26.076	25.902	25.729
.90	25.556	25.383	25.211	25.039	24.867	24.696	24.525	24.355	24.185	24.015
.91	23.846	23.677	23.509	23.341	23.173	23.005	22.838	22.672	22.506	22.339
.92	22.174	22.009	21.844	21.679	21.515	21.351	21.188	21.025	20.862	20.700
.93	20.538	20.376	20.215	20.054	19.893	19.733	19.573	19.413	19.254	19.095
.94	18.936	18.778	18.620	18.462	18.305	18.148	17.991	17.835	17.679	17.524
.95	17.368	17.214	17.059	16.905	16.751	16.597	16.444	16.290	16.138	15.985
.96	15.833	15.682	15.530	15.379	15.228	15.078	14.928	14.778	14.628	14.479
.97	14.330	14.181	14.033	13.885	13.737	13.590	13.443	13.297	13.149	13.003
.98	12.857	12.712	12.566	12.421	12.276	12.132	11.988	11.844	11.700	11.557
.99	11.414	11.271	11.129	10.987	10.845	10.704	10.562	10.421	10.281	10.140
1.00	10.000									

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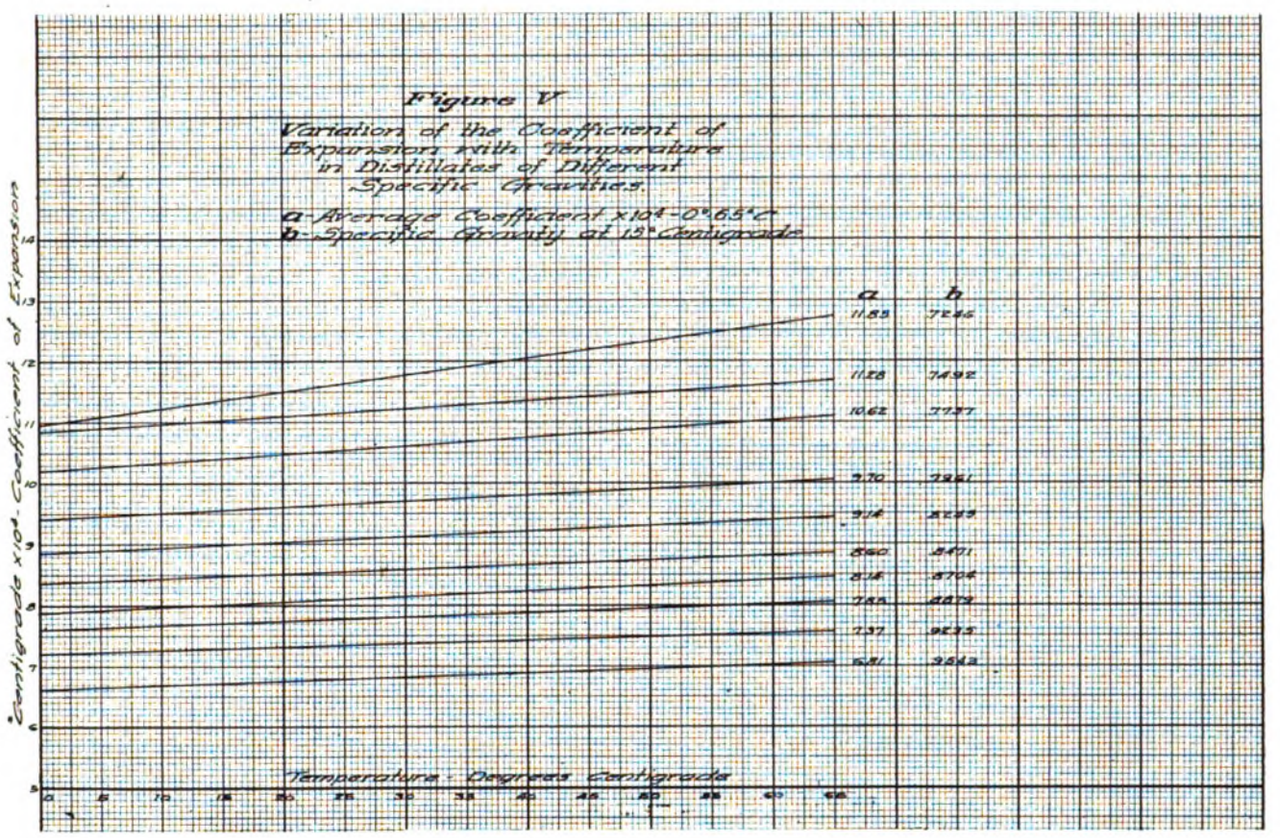

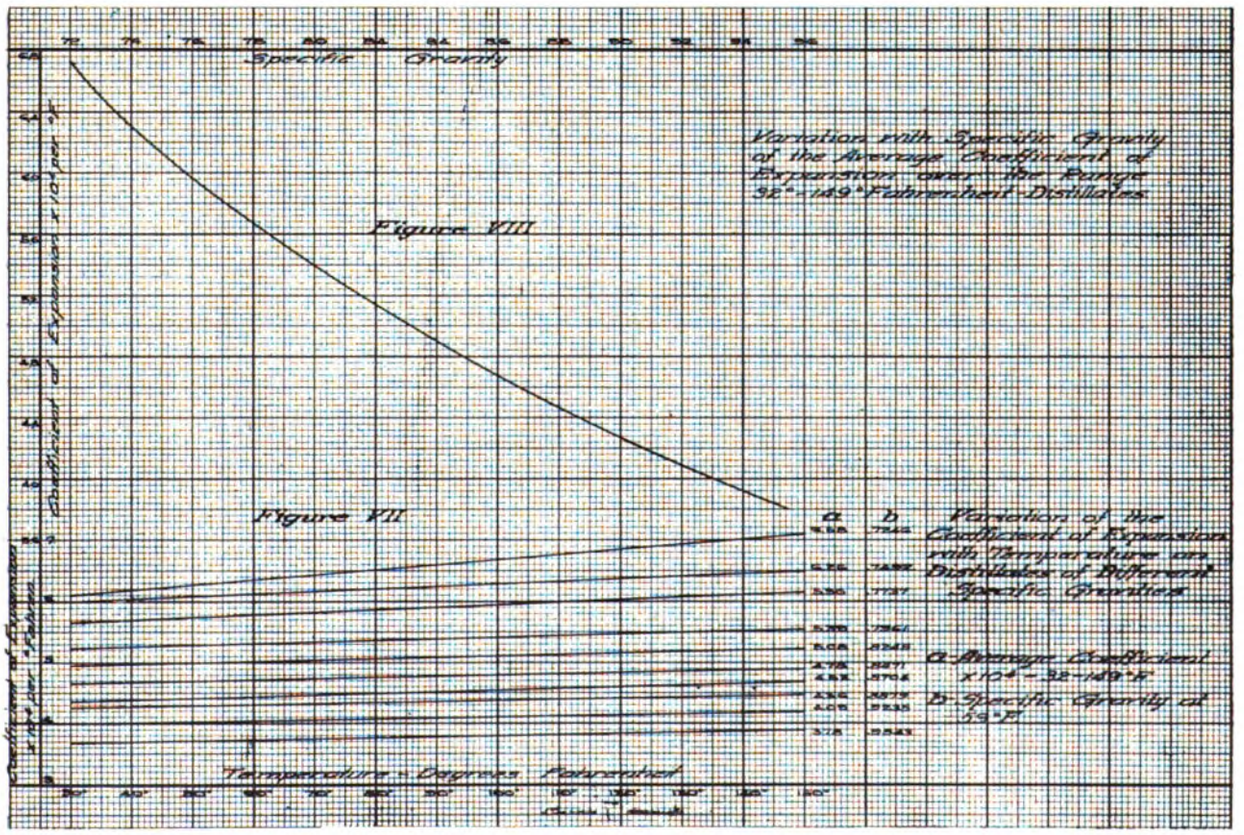
Specific Gravity
Figure VIII
Variation with Specific Gravity of the Average Coefficient of Expansion over the Range 32°-149° Fahrenheit-Distillates
Figure XII
a b
Variation of the Coefficient of Expansion with Temperature on Distillates of Different Specific Gravities
a-Average Coefficient x10⁴ - 32-149° F
b-Specific Gravity at 59° F
Temperature - Degrees Fahrenheit

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residuums irrespective of the character of the oil from which they were derived.

The values of Table 2 were plotted as were those in Table 1, and are shown in Figures V, VI, VII, and VIII. As in the case of the crude oils, the coefficient appears to be a straight-line function of the temperature. It is to be noted, however, that the variation with specific gravity deviates somewhat from a straight line. This may be true, too, in the case of crude oils, if the samples tested have a sufficiently wide range of specific gravity. For all practical purposes the curves as shown can be utilized for calculating the coefficient of expansion of the ordinary California crudes and distillates.

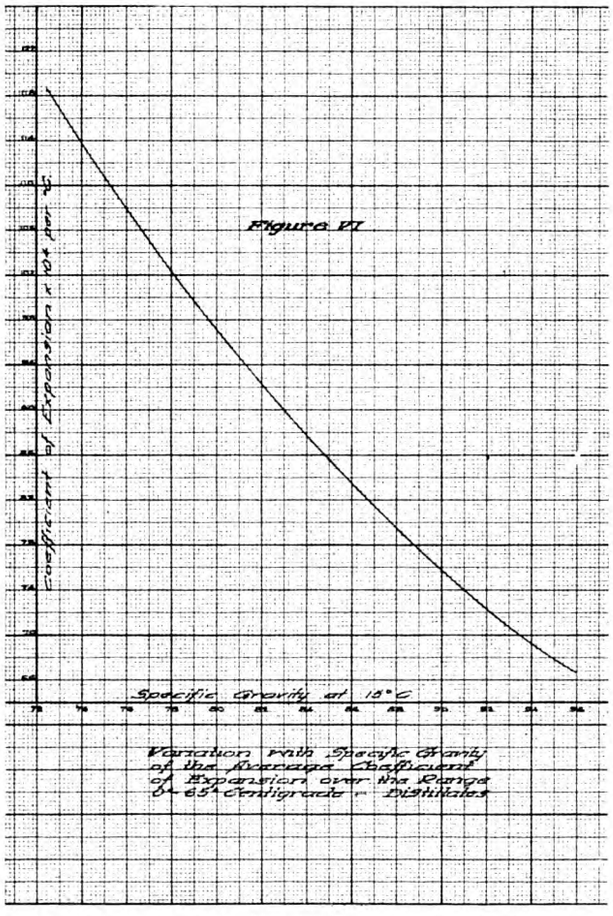
Figure VI
Specific Gravity at 15°C
Variation with Specific Gravity of the Average Coefficient of Expansion over the Range of 65° Centigrade - Distillates

Application of the Curves. From the information given it is obvious that it is not possible to use one value for the coefficient for oils of different gravities and at different temperatures. However, with the substitution of values obtained from the curves in the proper formulæ the exact values of the volume and specific gravities at standard temperature can be obtained from values determined at any other temperature.

The formulæ to be used are:

$$V_{15^\circ} = \frac{V_t}{1 + x\,(t - 15^\circ)}$$

$$S_{15^\circ} = S_t\,[1 + x\,(t + 15^\circ)]$$

Where V_{15} = volume at 15°C.

V_t = volume at t°C.

t = temperature at which measurements are made

X = coefficient of expansion over the temperature range t–15°

S_{15° = specific gravity at 15°C.

S_t = specific gravity at t°C.

Examples:

1. Unit weight of oil No. 1524 at 65°C. has a volume of 1.1374 units and a specific gravity of 0.8792.

First, using the approximate average value of the coefficient of 0.00072.

$$S_{15} = 0.8792[1 + 0.00072(65–15)] = 0.9108$$

Then from Figure II find the mean value of the coefficient for an oil of specific gravity 0.9108. This is 0.000759. Then in column 'a' of Figure I, find the curve which most nearly corresponds to the value of 0.000759. The nearest value is 0.000758, and on this curve the value of the coefficient at 65°C. is 0.000772. Substituting this value of X in the formulæ.

$$S_{15} = 0.8792[1 + 0.000772(50)] = 0.9131$$

$$V_{15} = \frac{1.1374}{1 + 0.000772\ (50)} = 1.0951$$

The values actually determined for the specific gravity and volume at 15°C. were 0.9132 and 1.0951, respectively.

2. Unit weight of oil No. 1528 at 5°C. has a volume of 1.0289 units and specific gravity of 0.9719. Substituting the approximate value of the coefficient of 0.00072.

$$S_{15} = 0.9719[1 + 0.00072(5–15)] = 0.9649$$

Then from Figure I, the mean value of the coefficient of an oil of specific gravity 0.9649 is 0.000679. Then from column 'a' of Figure II, the curve with a mean value nearest to 0.000679 is seen to have a mean value of 0.000679, and the value of the coefficient at 5° is 0.000666. Substituting this value of X in the formulæ:

$$S_{15} = 0.9719[1 + 0.000666(5–15)] = 0.9654$$

$$V_{15} = \frac{1.0289}{1 + 0.000666\ (5 - 15)} = 1.0358$$

The values actually determined for the specific gravity and volume at 15°, were 0.9654 and 1.0358, respectively.

In practice, where the Fahrenheit scale and a standard of 60°F. are used, Figures III and IV, and VII and VIII, are to be used. Table 3 permits of the conversion of Baumé gravity to specific gravity.

Conclusions. 1. The value of the coefficient now used in California practice approximates 0.0009 per 1°C. (0.0005 per 1°F.). From the results of this investigation it is apparent that this value is considerably too high, and that the correct value more nearly approaches 0.00072 per 1°C. (0.0004 per 1°F.).

2. The value of the coefficient for crude oils and distillates within the ranges of temperature used is a straight-line function of the temperature and increases with an increase in temperature.

3. The value of the coefficient for crude oils within the ranges of specific gravity used is a straight-line function of the specific gravity and decreases with an increase in specific gravity. The value for distillates deviates somewhat from a straight line.

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Standardizing Rock-Crushing Tests

By M. K. RODGERS

*Reports of rock-crushing tests should include the following details and forms for tabulation of such tests should be arranged accordingly.

1. Description of the machine employed (jaw or gyratory crushers, rolls, stamps, tube-mills, Chilean mills, etc.)

2. Material (timber, concrete, etc.) of foundation. Power is lost in the vibration of poor foundations.

3. Locality, geological, mineralogical, and physical characters of the rock.

4. The power consumption of the machine with no load and full load: the unit being 1 hp. per 24 hours.

5. The capacity of the machine in tons (of 2000 lb.) per 24 hours.

6. The duty in tons per horsepower-day.

7. The screen analysis of feed and product by the proposed A. I. M. E. standard screen-scale.

TOUGHNESS OF ROCK. Table I shows the relative duty of the same machine on three different rocks, all other crushing conditions being the same.

This table indicates that the specific resistance of the rock to crushing, may affect the crushing duty of a unit of power as much as 300%. Perhaps this quality may be called toughness. It is not a function of hardness only. For comparison of tests, rocks should be divided into at least three classes in this respect, determined by the crushing strength per square inch.

SCREENS. For screen analysis, a standard screen-scale, of a uniform ratio between sizes, should be used.

The results of an investigation made by the U. S. Bureau of Standards, with several of the large mining companies, where 240 to 260-mesh screens are used in connection with flotation tests, and including several cement manufacturers and screen manufacturers, are that a screen-analysis for all rock-crushing tests, and practically all testing of materials, will be covered by a screen-scale based on the U. S. Bureau of Standards, 200-mesh screen with a square opening of 0.0029 in. and a wire of 0.0021 in. diameter, advancing with a ratio of 1.414 (the square root of 2, suggested by Rittinger) between the successive sizes of screens, to a square opening of 4.197 in., the area corresponding to 4-mesh; for cases finer than 200 mesh, a 280 mesh or 0.0020 opening, with the above ratio, could be used.

If the analysis is to be carried finer than 0.0029 in. (200 mesh), the next finer sieve-opening in the Screen Scale Series, is 0.002 in. (280 mesh).

*Abstract of paper read at the September meeting of the American Institute of Mining Engineers.

TABLE I.—*Relative Crushing Duty of the same Rock-crushing Machine on Three Different Characters of Rock, all Other Crushing Conditions Being the Same*

Rock and Feed	Mill	Per Cent. Solids	H.p. of Machine	Tons per Machine, 24 hr.	Tons per Hp.-Day	Tons 200 Mesh per Hp.-Day	Screen Scale +4+10+20+40+60+100+200−200							
Calumet & Hecla conglomerate, ¼ mesh.	Conical tube 8 ft. by 30 in.	40	50.0	65	1.30	0.44	Feed	0	65	29	5	1	..	..	..
							Product	..	..	..	3	9	13	41	34
Cœurd'Alêne quartzite, F. M. & S. Co., 5 mm.	Conical tube 8 ft by 22 in. 28 r.p.m.	43	47.5	112	2.50	0.67	Feed	0	43	43	11	1	1	1	1
							Product	..	..	2	22	18	19	12	27
Miami, ¼ mesh.	Conical tube 8 ft. by 22 in.	27	47.5	229	4.85	1.80	Feed	4	45	33	10	2	2	1	7
							Product	..	..	2	14	12	17	14	38

Relative crushing duty of 1 hp. due to character of ore only:

Calumet & Hecla Conglomerate	1.00
Cœur d'Alêne Quartzite	1.92
Miami	3.75

TABLE II.—*Standard Screen Scale*

Mesh per Linear Inch	Opening, Inches	Opening, Millimeters	Diameter of Wire, Inches	Diameter of Wire, Millimeters	Area of Openings, Square Inches
	4.20	106.60	0.375	9.52	17.64
	2.97	75.39	0.207	5.26	8.82
	2.10	53.33	0.192	4.88	4.41
	1.49	37.73	0.149	3.78	2.20
	1.05	26.67	0.149	3.78	1.10
	0.742	18.85	0.135	3.43	0.551
	0.525	13.33	0.105	2.67	0.276
	0.371	9.423	0.092	2.34	0.138
3	0.263	6.680	0.070	1.78	0.069
4	0.185	4.699	0.065	1.65	0.034
6	0.131	3.327	0.036	0.91	0.017
8	0.093	2.362	0.032	0.81	0.0086
10	0.065	1.651	0.035	0.89	0.0042
14	0.046	1.168	0.025	0.64	0.0021
20	0.0328	0.833	0.0172	0.44	0.00108
28	0.0232	0.589	0.0125	0.32	0.00054
35	0.0164	0.417	0.0122	0.31	0.00027
48	0.0116	0.295	0.0092	0.23	0.000135
65	0.0082	0.208	0.0072	0.18	0.0000672
100	0.0058	0.147	0.0042	0.11	0.0000336
150	0.0041	0.104	0.0026	0.07	0.0000168
200	0.0029	0.074	0.0021	0.05	0.0000084

If the analysis is to be carried finer than 0.0029 in. (200 mesh), the next finer sieve-opening in the Screen Scale Series, is 0.002 in. (280 mesh).

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The Development of the Steel Drilling-Rig*

By R. B. WOODWORTH†

To make the discussion clear, a distinction should be drawn between drilling-machines and drilling-rigs. The former is a general designation given to well-known types of drilling-equipment mounted on wheels and easily portable by their own or other power from place to place without disassemblement. A drilling-rig is a structure with its mechanism adapted to boring holes of great depth and removable from place to place only by disassemblement of its parts. An outfit includes, in addition to the derrick, machinery-supports, wheels, etc., the boiler, engine, tools, rope, casing, and whatever materials are necessary for the complete operation of sinking holes. The steel drilling-rig discussed in this paper is the structure and the essential operating mechanism together with the house covering, etc., but does not include the drilling-tools, etc.

There are three distinct types of rigs in use in the United States. The standard rig was first developed in the sinking of salt-wells in the Appalachian district and subsequently improved upon in its application to the drilling of wells for oil and gas. Its prime mover is a band-wheel; two pulleys are used on the crown block and the hoisting is done by a single bull-wheel.

What is often designated in the Pacific Coast oilfields a 'standard rig' is called a 'California rig' in this paper. It is essentially a standard or Pennsylvania rig with the addition of a calf-wheel for hoisting and lowering casing and additional pulleys on the crown-block.

The rotary rig as used in the Gulf Coastal plain consists substantially of a derrick with a set of drawworks and with a rotary for its drilling mechanism in place of cable tools. Rotary-derricks usually have five-pulley crown-blocks. The ordinary practice in Texas is to drill the well with the rotary and after completion to install the main operating parts of a standard rig to be used in the subsequent operations of cleaning, pulling tubing, deepening the well, etc. A completed well drilled with a rotary when equipped for maintenance is fitted up substantially in the same manner as a well drilled with a standard rig.

Combination rigs are designed to facilitate the speedy interchange of cable tools or rotary in the actual process of drilling. When the combination is made of a rotary rig and a standard rig, that combination is ordinarily designated a standard combination rig. When, owing to drilling conditions, it becomes necessary to utilize a calf-wheel or, in other words, to design a structure which permits the interchange of cable tools and rotary and at the same time utilizes the calf-wheel for casing operations, such a rig is denominated a 'California combination rig.' It is obvious that this type of rig possesses more flexibility than any of the other four, and it becomes, therefore, the most complete and perfected class of drilling equipment.

With these distinctions and nomenclature in mind, we are prepared to take up the development and the gradual perfection of the drilling structure. The history naturally falls into four general subdivisions:

1. Introduction and perfection of the steel derrick.
2. The first endeavors to construct a complete rig.
3. The completed steel rig in its earlier form.
4. The extension of the completed rig to diversified service.

1. Introduction and Perfection of the Steel Derrick. The earliest appearance of the structural steel derrick known to me is in a catalogue published by the Oil Well Supply Co. in 1892. This was 72 ft. high, made with steel angle-legs, steel base and crown-block and with diagonal members made of round rods and adjustable by the use of turnbuckles. There were nine panels. One of these derricks was shipped to Australia to be used in a district where wood decayed rapidly, and another was shipped in 1894 to Teheran, Persia. They also appeared in the Oil Well Supply Co.'s catalogue, issue of 1900, and in a catalogue issued in 1897 by the National Tube Works Co. in French and English and intended for circulation abroad.

It is probable that few besides these two were constructed, but in 1903 a new endeavor to introduce structural-steel derricks was made. In that year the Pittsburgh plant of the American Bridge Co. built derricks for the Oil Well Supply Co. in heights of 50, 60, and 70 ft., tower fashion, with three, four, and five panels, that is to say panel heights on an average were 17, 15, and 14 ft. The same year the Chester B. Albree Iron Works built two or three structural steel derricks of the same general design on the order of the National Supply Co. for shipment to Vera Cruz, Mexico. These derricks were 70 ft. 8 in. high with an average panel height of 14 ft. In that same year the Carnegie Steel Co. built 12 derricks for the South Penn Oil Co. and the Carnegie Natural Gas Co. These derricks were 80 ft. in height, 20 ft. base and were complete in seven panels averaging a little less than 12 ft. in height. The derrick and base weighed 24,000 pounds.

These three lots of derricks were built by men experienced in structural-steel work but without intimate acquaintance with oilfield practice. While, therefore, they proved to be satisfactory and were moved and reerected in the drilling of more than one well each, they were not adapted for economical service, neither did they conform to the type of construction with which rig builders were familiar.

*Paper presented at the meeting of the American Petroleum Society, San Francisco, October 1915.

†Engineer, Carnegie Steel Co., Pittsburgh, Pennsylvania.

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Their performance was sufficiently satisfactory, however, to indicate that a satisfactory derrick might be constructed at a reasonable cost, and the designers of the Carnegie Steel Co. continued to work on the problem in co-operation with the officials of the Oil Well Supply Co. A revised design was introduced in 1904. Previous designs had utilized supporting buttresses outside of the leg-sections to take care of what the structural-steel men considered to be unbalanced stresses; in this design these buttresses were eliminated and the size of the members was reduced so as to make a lighter structure.

The present type of structural-steel derrick was designed in 1908. The legs, girts, and braces are made of steel angles. The splices were originally made of steel plates. The splices of the most modern type of derrick intended for use in comparatively easy drilling are made of square-root angles. The essential differences between present practice in manufacture and the practice in 1908 consists in the treatment of the joints rather than in the sizes of the main members. The number of bolts at a joint has been reduced to 8 and the total number per panel to 32. The difference is due to the fact that the dependence for the transmission of stress from one leg-section to another is placed on perfection of workmanship and not on the transfer of loads through the bolts. These are intended to be of ample strength for the wind stresses and of sufficient number to hold the joint in line and to prevent its movement under any probable upward tension caused by unequally distributed loads on the crown-block, but not to develop the full strength of the leg-sections.

The square-root angles, however, are only made in sizes large enough to splice 4 or 5-in. leg-sections. On the larger-sized derricks, such as those used with the 106-ft. steel drilling-rig, it is necessary to use plates. The leg-sections are not faced but the holes in the upper section are spaced on a slightly larger spacing than the holes in the splice, and in consequence when erected, the two sections butt smoothly and tightly together.

Another type of derrick-joint, however, has come into extensive use and is suitable for the lighter forms of structures. The ends of the leg-sections are slotted. There are slots also in the top of the splices and in the derrick-girts and braces. The bolts are put through these slots but remain permanently in position except that the nuts have to be unscrewed part way when the derrick is disassembled for removal. This is known as the 'Yorke joint,' after its inventer, Patrick Yorke of Washington, Pennsylvania.

A new splice has been recently devised by Philip Foukes, foreman of the Upper Union Mills fitting shop of the Carnegie Steel Co. This is intended for light drilling service and consists of a steel plate bent around the leg-section. The girts and braces are attached to the splices through lugs. The lugs and bent plates are united by three volts. When these are tightened they clamp firmly all of the various parts at the intersection, the leg-sections, lugs, girts, and braces, while the spring of the plates prevents the dislocation of nuts. There are three bolts at a joint instead of the eight used in the Yorke and Woodworth types of derricks of equivalent theoretical strength.

There are many pipe-derricks in use in Eastern oil and gas fields made in a variety of ways. Typical of these are the derricks made by Lee C. Moore & Co. in accordance with patents issued to T. A. Neill, field superintendent of the South Penn Oil Co. The joint-clamp is made of a steel plate drop-forged to shape with lug for the attachment of girts and braces by means of bolts. Nine bolts are used in the standard drilling-derrick at each joint. Second-hand pipe may be used in the manufacture of these derricks. There are many of them in use, particularly as pumping-derricks over producing wells.

2. First Endeavors to Construct a Complete Rig. The derrick shown in the Oil Well Supply Company's 1892 catalogue was intended to be used with sectional wheels, steel walking-beam, steel samson-post, steel foundation, etc., so as to form a drilling-rig at least in its essential features, and a set of wheels constructed for rigs of this character was exhibited at the World's Fair in Chicago, 1893. The design, however, did not contemplate the construction of engine and belt-houses, derrick roof or other similar features intended for the protection and convenience of the workmen.

In the steel drilling-rig designed by the Carnegie Steel Company in 1904, provision was made for steel derrick, crown-block, ladder and base, steel bull-wheel and calf-wheel posts, steel foundation, machinery-supports and steel walking-beam. Bull and band-wheels and calf-wheel were made of wood. The derrick was 72 ft. high and the parts of the rig weighed 34,000 lb. Designs for steel wheels had already been made, but those used with these rigs were of wood.

3. Completed Steel Rig in Its Earlier Form. The first complete steel rigs were designed and constructed in 1908 for the Carnegie Natural Gas Co. for use in Washington and Westmoreland counties, Pennsylvania and Wetzel county, West Virginia. The working parts of these rigs were built entirely of structural steel with the exception of the crown-pulley and sand-reel which had been made already in metal. The house framing, however, was continued out only so far as the sand-reel, the remainder of the belt-house and engine-house being made of wood. This latter defect was remedied in the three 80-ft. Woodworth drilling-rigs built for the same company in 1909 and first erected at Avon, Ohio, and Lumberport, West Virginia. By the end of 1910 one of the 80-ft. rigs made in 1908 had drilled five wells with a total depth of 13,901 ft., and up to the end of 1912 one of the 1909 rigs first erected at Avon, Ohio, had drilled six wells with a total depth of 17,808 ft., one of which was 4440 ft. deep.

4. Extension of the Completed Rig to Diversified Service. There are three main classes of services for which bore-holes are drilled—mineral exploration work, sinking of water-wells and the sinking of wells for oil and gas. The steel derrick since its introduction has found use in each one of these fields. It has also been

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used with each of the recognized methods of drilling.

The 80-ft. standard rigs were followed by the manufacture of 72-ft. standard rigs. A few of these latter rigs have been used in western Pennsylvania and West Virginia. Their greatest use has been in Wyoming and Oklahoma. They were constructed with the same size angle-legs as the 80 ft. derricks, on the assumption that while the tools were shorter and the derrick could be called upon to handle only two joints of casing at a time, the total load on the structure would not be essentially different.

The first 80-ft. California drilling-rig built in accordance with the 1908 design was made in 1911 and shipped to Cardenas, Cuba. This same year many of the 72-ft. California rigs went to Casper, Wyoming, and were used in the development of the Salt Creek field. The 72-ft. and 80-ft. California rigs made up to that date were designed to carry the same theoretical working stresses as the 72-ft. and 80-ft. standard rigs which had been found to be of sufficient strength for all reasonable requirements in the Appalachian oilfields. It was recognized, however, that most modern California drilling required heavier structures, and designs were, therefore, made for derricks, machinery-supports and operating mechanism which would be capable of drilling 5000 or 6000-ft. wells under the severest conditions. The first 80-ft. heavy California derricks were manufactured in 1913 and it is singular to note that these were not used for oil or water-well drilling but were employed by the Duquesne Light Co. at Neville Island, Pittsburgh, in the support of light cables and other wires across the Ohio river during the reconstruction of a railroad bridge.

The pure rotary rig as used in the Gulf Coastal plain is nothing more than a derrick equipped with a five-pulley crown-block and provided with draw-works posts, with hoisting-drums, and with a rotary for drilling. When the well is completed and put to pumping, the rig is extended to include the parts used in standard cable-tool practice. Steel rotary derricks were first offered for sale in July, 1911. The first was 64 ft. high and was sold to the Hughes Specialty Well Drilling Co. at Charleston, South Carolina. It has been used in the drilling of water-wells in Georgia, Alabama, South Carolina, and Florida. The 86-ft. rotary derrick came in due season and also the 106-ft. heavy Woodworth rotary derrick, the first of which was made in 1913 for the Oil Well Supply Co. and shipped to the American Trading Co. at Buenos Aires, Argentine Republic. The 86-ft. rotary derrick will handle three lengths of pipe and the 106-ft. four lengths with ample clearance for the heaviest sheaves and casing-hooks.

The first two standard combination rigs were built in 1912. The first 80-ft. California combination rigs were built the same year for the Penn-Mex Fuel Co. at Tampico. The first 80-ft. heavy California combination rigs were made in 1913 for the Caribbean Petroleum Co. and shipped to Maracaibo, Venezuela. These rigs were constructed for the use of a single engine located back of the band-wheel as in a California rig and the line-shaft of the draw-works was driven by sprocket-drive from an auxiliary sprocket placed on the band-wheel shaft between the band-wheel and the inner jack-post. This construction places the draw-works on the walking-beam side of the rig or in the identical position occupied by the calf-wheel in a California rig. Interchange of tools may be effected without change in the structure, but in the California combination rigs made after this design, change from cable tools to rotary or vice versa may be effected only by the removal of the draw-works posts and their replacement by the calf-wheel posts or vice versa. The 106-ft. heavy Woodworth-California combination rig erected at the Panama-Pacific International Exposition is constructed so as to be driven by two engines, one to drive the rotary and the other to drive the cable tools. This method of construction permits the greatest possible degree of interchangeability inasmuch as both the rotary hoisting-drum and calf-wheel have their own independent supports which need not be disturbed when change of tools is made.

The first combination structural and pipe drilling-rigs were made in 1909 for use of the South Penn Oil Co. in the Shinnston, West Virginia, oilfield. Numbers of these steel rigs, more or less complete, for use with pipe derricks have been built since that date, chiefly in conjunction with Lee C. Moore & Co., manufacturers of the Neill patent pipe derrick.

Structural steel drilling-rigs adapted to the Canadian method of drilling have been manufactured by the Deep Well Tool & Boring Co., St. Albans, England, and by the Oil Well Engineering Co., Manchester, England. Steel drilling-rigs adapted to the Galician method of drilling are also advertised by the Galician-Carpathian Petroleum Co. I have no specific information, however, as to how extensive their use has been or what part of the complete equipment is furnished by those companies.

Conditions Which Influence Structural Design. The problem which confronted the designer when he began to consider the substitution of steel for wood in the construction of drilling equipment was not a simple one, in spite of the fact that in popular conception all derricks look alike, and further that men accustomed to operation in a limited field naturally imagined that when their particular problems were solved, the solution was applicable to all other problems elsewhere. It should be borne in mind, however, that in addition to the methods of drilling and hoisting which are the most immediate considerations in the design of drilling equipment, there are variations in other features, due to the arrangement of engines, to the size and depth of wells, to the character of the strata penetrated, to the preservation and maintenance of wells after completion, to the means taken for the convenience and protection of workmen and to the removal and re-use of the equipment after it has served its purpose at any one particular well, added to which there are other personal preferences of individual operators, which may cause fundamental divergences even in districts

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where all the other conditions are essentially similar.

As has already been noted, the heights of drilling derricks are determined by the length of the tools and hoisting-tackle in cable-drilling practice, and by the number of joints of casing or drill-pipe hoisted in rotary-drilling practice. It is the latter feature which accounts for the extremely high derricks which have come into experimental use.

The strength of a derrick or drilling rig should bear a definite relation to the service which it has to perform. Considerations of transportation and erection, as well as economy in first cost, require that it be built as light as possible for the service. So far as the derrick itself is concerned, there is little waste of wood in the usual method of construction. All the steel designer has to do, therefore, is to substitute sections of equivalent strength which in turn are approximately of the same weight. There is, however, a great deal of waste in the wooden samson-posts, jack-posts, longitudinal and transverse sills, engine-blocks and other heavy portions of the structure. Here the substitution of materials of equivalent strength eliminates the excess weight, which is practically unavoidable in wooden construction and as a consequence a complete steel drilling-rig of equivalent strength is some 25 to 30% lighter than a wooden rig of the same strength. A standard 80-ft. Woodworth drilling-rig with derrick, foundations, bull and band-wheels, house framing, corrugated sheeting, etc., weighs 45,300 lb. as compared with approximately 60,000 lb. for the same structure constructed of wood.

What loads the derrick should be figured to sustain is a matter not reducible to exact formulæ. Drilling loads are usually not severe. It is the hoisting service which brings the greatest stresses on the structure and this latter depends on the friction between the casing and the material with which it is surrounded, the straightness of the hole from which it is to be drawn and the eccentricity of the pull on the crown-block. The friction depends again on the size of the casing, its length, the pitch of the strata through which it passes, and the angle of repose of the materials therein. These are matters beyond practical ken. When the designer has computed the strength in accordance with the best information at hand, he has to add a percentage for unascertainable contingencies and in addition has had to remember that the driller is a very human personage and when the casing is 'frozen,' will load his engine to the limit for its extraction.

In the endeavor to design an 80-ft. heavy derrick for use in California oilfields, I compiled various records as to depths of wells, sizes and weights of casing used therein, etc. In the process of compiling I was advised by practical oil-men that the problem was to design a derrick of sufficient strength to pull 12-in. 40-lb. casing in two. That was some years ago and I have not yet been able to ascertain exactly the amount of pull required to do this. I have, however, built a number of heavy derricks which have been entirely satisfactory for field service.

It is desirable to adjust the sizes and weights of derrick members to the exact load requirements, but as far as the bracing system is concerned it is impracticable to do this. Certain sizes of angles or rods are made necessary by economic considerations of shop manufacture, and it is, therefore, practically impossible to use sections of the smaller sizes and weights which are the exact structural equivalents of the working-stresses. Consequently, the designer uses the smallest size angles (or pipe in the case of pipe derricks) which the canons of fabrication show to be expedient. When he has done this, however, his bracing system will be ample for all stresses in the derrick regardless of the load on the legs.

It is again essential for economy in manufacture that the external dimensions of the leg-sections remain constant so that the same set of shop-detail drawings will suffice for derricks of different capacities. This adjustment of leg-sections to theoretical working-loads is made in the wooden derricks by the nailing of additional planks to the normal leg-sections. It is done in just as practical a way in the manufacture of structural-steel and pipe derricks. In the structural-steel derrick the desired end is accomplished by increase in the thickness of the leg angles. The 80-ft. standard derrick in the regular grade has its leg-sections made of 4 by 4 by $\frac{5}{16}$-in. angles and the theoretical working-load with a factor of safety of four is 92,000 lb. Heavier grades are made with angles $\frac{3}{8}$ and $\frac{7}{16}$ in. thick and with working-loads of 110,000 and 127,000 lb. with a still further increase in strength, if desired. The 80-ft. regular California derrick is made heavier than the standard derrick. Its angles are $\frac{3}{8}$ in. thick and the superheavy grades are $\frac{1}{2}$ in. thick, with a safe working load of 144,000 pounds.

The heavy derricks, whether 80, 86, or 106 ft. high, are made with 6 by 6 by $\frac{3}{8}$-in. angle-legs with a theoretical working load of 223,000 lb. The extra heavy and superheavy grades are made with angles $\frac{7}{16}$ and $\frac{1}{2}$ in. thick and with working loads of 259,000 and 294,000 lb. The thicknesses given are the thicknesses of the leg angles in the top section. It is usual to increase the thickness from the top downward in order to take care of the increase in stresses due to wind and working-loads, particularly in the bottom panel, which is of greater height than the others.

In the case of pipe derricks the same adjustment of stresses is made by the increase in the thickness of the pipe itself and also for heavy service by inserting smaller sizes of pipe within the pipe section itself. Derricks constructed in this manner are called 'duplex' or 'triplex,' depending on whether there are two or three pipes in each length of leg-section.

Corresponding adjustments are made throughout the entire rig. It is recognized that the loads on a heavy drilling rig require heavier equipment in the operating mechanism. It has been found that a 10-ft. band-wheel with $4\frac{1}{2}$ or 5-in. shaft is sufficient for use with the regular grades of derricks. An 11-ft. wheel with a 6-in. shaft is the standard size for use with the heavy rigs.

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These different sizes carry with them a corresponding increase in the strength of the crown-block, jack-posts, foundation-sills, etc.

The 106-ft. Heavy Woodworth California Combination Drilling-Rig. We have now come to a technical description of the 106-ft. drilling-rig exhibited at the Panama-Pacific International Exposition. The lines along which this rig has been designed have been those already stated, not to deviate from recognized standards of construction in wood and to utilize such materials in the way of rig irons, bearings, etc., as can be gotten from oil well supply stores. At the same time one or two innovations have been introduced which are worthy of mention. The system of bracing bull-wheel and calf-wheel posts customary in wooden and steel rigs alike has been applied to the draw-works posts as well, so that these posts, in addition to their own strength, are aided and assisted by solid braces. The walking-beam, in addition to being counterbalanced, is provided with revolving centre-irons, so as to permit it to be swung to one side readily when the rotary is in use. The walking-beam is likewise equipped with a spring-box at the pitman-end so as to give perfect resilience to the beam whether used with Manila drilling-cable or with wire rope. This spring-box is a recent invention and has come into use not only with the steel walking-beam, but also with the wooden beams when used with wire line.

As a means of comparison, there is given below a table showing the detailed specifications and approximate weights in pounds of this rig. This table includes all the materials usually furnished by the manufacturers and covered by the designation 'drilling-rig,' as already explained. This table does not include, of course, the weight of the wood used for derrick-floor and for nailing-strips; otherwise, it is complete.

	Approximate weight in pounds.
Derrick, ladder and heavy crown-block	28,960
Seven crown, sand-line, and casing-pulleys	1,430
9-in. brake-band, lever and staples	300
Bull-wheel posts, braces, and bearings	940
Calf-wheel posts, braces, and bearings	960
Draw-work posts, braces, and bearings	1,710
Foundation	7,350
Machinery supports, braces, and bearings	8,830
House framing	5,720
Walking beam and bearings	2,500
Pitman spring-box	70
Revolving centre-irons and stirrup	820
8-ft. bull-wheel, long shaft	3,670
11-ft. band-wheel	3,210
6-in. superior band-wheel shaft, crank, wrist-pin and keys	1,400
42-in. California double-drum sand-reel	2,000
7½-ft. calf-wheel, sprocket-rim	2,210
7-in. brake-band, lever and staple	300
42-in. sprocket, clutch, keys, etc.	700
55-ft. sprocket chain	500
323 pieces galvanized, corrugated iron	4,930
2 engine blocks	2,800
Total, complete rig	81,310

Erection of this rig was performed by unskilled workmen. Cost of labor, including carpenter-work in laying the floor, building platforms, etc., amounted to $258. Under ordinary conditions a rig should be erected complete by experienced rig-builders at a cost not to exceed $200, and be taken down and re-erected for $250. The rig is, as far as possible, fireproof; nothing can wear out except the wooden cants, which are easily renewable. Ordinary repairs, on removal, should consist merely of the renewal of the cants and replacement of bolts damaged in handling.

RECLAMATION WORK IN HAWAII

The Territory of Hawaii now has in hand reclamation works that will cost about $300,000, with several other projects in contemplation. At Honolulu a strip of land half a mile wide, starting near the wharves and extending for about three miles along the shore, is being put in sanitary condition. Another project well under way, known as the Waiolama reclamation project, will improve the water-front of Hilo, on the island of Hawaii. This tract has been condemned and notice served by the department of public works upon the property owners. Within a few weeks the contract will be let and active filling operations commenced. Preliminary surveys are being made for the Waikiki reclamation project, and filling will soon begin. This parcel of land adjoins the famous Waikiki beach, and its reclamation will open up a large area of desirable residence property. In all these filling operations a suction-dredge is employed. The cost is from 40 to 45c. per cu. yd. To start this work the Territorial Legislature appropriated $300,000. Property owners are allowed five years in which to make payment of the costs assessed against them, and as fast as the money is returned it becomes available for new projects. In this way the maximum amount of improvement will be accomplished in a comparatively short time.

A bibliography of the Chemistry of Gas Manufacture has just been issued by the United States Bureau of Mines as Technical Paper 120, the authors being W. F. Rittman and M. C. Whitaker. The references in this bibliography are selected from a much larger list gathered by the authors during several years of research work on problems dealing with the chemical behavior of hydrocarbons. No attempt is made to cover every phase of gas manufacture, including the construction and operation of plants, the object being to present a bibliography of carefully chosen references dealing with the chemistry of gas making and the chemical changes involved in the production of combustible gases. In view of the fact that there is no such published bibliography, the list, together with the cross references contained therein, is published by the Bureau of Mines in the hope that it will serve as an efficient guide for investigators, chemists, and engineers, and for operators of gas plants. Copies of this paper may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

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Factors Affecting Fire Hazard of Oil Producing and Refining Properties*

By A. W. GUNNISON†

Introduction. The subject of fire-losses and fire-prevention should be of vital interest not only to those financially interested in oil-properties but also to the general public. In view of the dearth of literature on the subject, the following summary has been prepared concerning the factors that have a bearing in the determination of fire-insurance rates. Where the precautions noted are observed, relatively low rates can be granted.

Derricks. The best construction, except where lightning is common, is a metal frame with non-combustible floors and walls. In such cases a continuous enclosure to include the engine would not be objectionable unless the latter were a gas engine with open heating-torch, in which case there would be chance of ignition of gas from the well. Metal framing would reduce hazard from friction at the crown block, etc. A considerable amount of enclosing woodwork would reduce efficiency of steel frame and probably wreck it. Boilers should never be housed in with the rest of the rig. Wells pumped with a jack need not be enclosed at all and would then have a slight fire-hazard, with corresponding low insurance rate.

Forges or open lights add to dangers in drilling. They should not be inside, particularly where gas pockets may be encountered in drilling. Engines and moving machinery of any kind have hazards of accidental friction or failure of lubrication. Belt-houses should be of non-combustible material throughout and merely enough of a structure to provide shelter from the weather. Gas from wells should be piped away properly. Steam-pipes or gas-engine exhaust should not touch woodwork, grass or rubbish. Gas-engine ignition should preferably be by electric spark instead of torch. Electric-wiring should be according to rules, and lights protected by screen. Lights in territory where gas may be found should have proper vapor-globes. Switches should be well away from derrick. Night-watchman or pumper should carry an electric pocket-torch.

Rope-drive leaves quantities of frayed material, which should be carefully removed. Waste oil should be gathered by a trench and piped to a sump. No sumps or open-top tanks should be allowed within 100 ft. of derrick, or be connected to it by combustible troughs. There should be no grass, trees, or brush within 50 ft. of a derrick, tank, or sump. Buildings increase the hazard more or less, in proportion to their construction and their occupancy. They should be over 100 ft. from the derrick and its sump.

For extinguishing fires, water under pressure thrown on the woodwork has its value, even if it is oil-soaked. Pools of oil when once ignited are not so easily handled. Sand with scoops would be better. Carbonic-acid chemical-extinguishers are of some use except in the open air. Carbon-tetrachloride extinguishers do good work on small fires and where there are electric currents, as it is claimed the liquid is not a conductor of electricity.

Separating-Tanks and Sumps. For the sake of both derricks and oil, these should be a safe distance from the derrick, 200 ft. being none too far, though convenience of operation is likely to bring them into the derrick group. Chances of fire are lessened by having the tanks covered and by the use of solid steel for tanks instead of thin metal to which it is hard to attach fittings. Wooden stilts holding tanks up from ground are a weakness. Where water is to be separated from oil by heat, heating-tanks should be well away from other damageable property. High-voltage electric-separators are particularly dangerous exposures. General rules for protection are the same as for larger tanks.

Collecting, Storage, and Pipe-Line Tanks. Oil in bulk generally receives careful handling, as the value increases. Tanks of over 10,000 bbl. should be of riveted-steel plates put together where they are to stand (not transported) with a factor of safety of 4 in all parts. Height not to exceed 30 ft. Cover or roof should have a non-inflammable upper surface. The most vulnerable parts of steel tanks are the eaves, where gas may escape, or flying sparks land on the projecting woodwork. An ideal cover would be one of solid metal with eaves-joints calked tight. Such a tank would require openings of sufficient size near the middle of the cover to allow air inside to expand and contract without buckling the tank. A wood-sheathed roof must project over the sides to allow rain-water to run off. It is an advantage to brace the sides so as to preserve the circular form, as tanks when empty are liable to change the outline. A scratching nail might cause a disastrous spark. Roofs have sometimes been crushed and greatly weakened by collapsing sides. Steam-jets under roofs have proved useful for smothering fires in covered tanks.

Wherever escaping oil on fire might damage other property it should be diverted or retained by adequate embankments. These would be useless, of course, where the oil and the exposed property are already close together. Tanks should be at least 100 ft. from other property, the distance being greater as the size increases. Explosive effects throw oil with a rush that would be likely to overtop too low a bank. To protect other property at a lower level, the capacity of the retaining-dam should be 1½ times that of the tank.

*Abstract of paper presented before the San Francisco meeting of American Petroleum Society, October 1915.

†Board of Fire Underwriters, Merchants Exchange Bdg., San Francisco.

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Thick oil requires heating to facilitate traveling through pipes. This should not be done in a large tank nor in any container where vapors could escape, as distillation might result. The heating should be by steam to temperatures not exceeding 180°F. This is a somewhat safer operation than heating to remove water. Electric wires should not be closer than 20 ft. from an oil tank, and should never run overhead.

Containers holding water along with oil are greater fire-hazards because of the frying effect caused by the water. Extinction of oil fires is especially difficult where containers are large; red-hot metal will rekindle blazes after apparent extinction. Water alone is frequently worse than useless, not only splashing the burning oil about but also adding to the frying effect noted above. Great quantities suddenly dropped on a tank may blanket a blaze, as at the Standard Oil Co.'s fire at San Diego. Sprays on the roof making a curtain of water on the sides would protect against exposure but would take a great deal of water. Steam jets under a cover or roof are helpful if the roof has not been already burned off or been ruined by explosion. Large steam-generating units are, however, a requisite for sure operation and controlling-valves should be at a safe distance from tank.

Watchmen should be maintained at all hours, preferably with a clock and stations to insure the actual visiting of hazardous or susceptible points at stated intervals. Fires could then be generally discovered at early stages and controlled. Pumpers making rounds to wells, in seeing tanks from various angles, afford excellent protection. Operators at long-distance pipe-line stations where hourly reports are telephoned to headquarters also afford some protection, though tanks may be seen at one side only.

The removal of oil during a fire may effect great saving, though lowering of the level of the liquid is sure to cause collapse of steel tanks. Attempts have been made to pump water in as oil is removed, but this requires large pumping-units and other complications, such as swing-pipes with remote cable-control. Oil can be removed by gravity if the outlets near the bottom are large enough and gates are provided at some distance from the tanks at a lower level. Cannon for shooting holes in burning tanks are likely to prove useless as the escaping oil is likely to ignite. A fully-equipped reservoir, connected to the pipe-line, but kept empty at ordinary times would be useful for storage in emergencies. Protection from lightning is ineffective, and until recently has seemed not worth while in California.

The most promising protective device for ordinary fires, and one having the specially good feature of being automatic, is the frothy mixture, which would seem to have given good results under test. Explosion would perhaps wreck it, but an ordinary blaze has been readily extinguished in open-top tanks 90 ft. in diameter. However, its efficiency in large fires has yet to be demonstrated to the satisfaction of the underwriters. Carbon-tetrachloride extinguishing has not given as good results, the liquid being heavy. If it could be properly vaporized it might be used to advantage.

Earth or Concrete Reservoirs. Fire in these is especially hard to handle on account of their large size, presenting a broad surface to the air, and, if covered, having a great quantity of wood to burn. They should, however, be less liable to lightning-strokes, and the sides stand up better when heated. Reservoirs with vertical reinforced-concrete sides would suffer, especially if cracks had previously developed. To a less extent, concrete-lined earth reservoirs would be badly damaged. Precautions as to cleanliness and clearing of grass should be taken, as with tanks; oil should be heated elsewhere, and it would be better to run piping over than through the sides. The larger the reservoir, the less value steam-smothering or other apparatus would have. Salvage of oil would also be secured in diminishing proportion.

Refineries: Stills, condensers, tail-houses and asphaltum-coolers naturally have their extra hazards. An important feature is the piping for carrying different oils, which is necessarily complicated here. Pipes should be in covered trenches or so high overhead that they cannot be accidentally broken and should be so arranged that expansion and contraction can be allowed for. Brickwork around stills and their supports should have similar attention. Drainage of ground should be away from fire-boxes; there should be no woodwork or other combustibles near. Explosion-traps should be provided; also steam for smothering. Asphaltum draw-offs should not be heated by direct flame. Stills and coolers should be away from combustible buildings. Gases not condensed should be burned, turned into stacks or carried well above danger. Electric-wiring needs particular attention, especially in the tail-house. No vapors or light oils should come in contact with air until delivered in tanks. Oil-pumps should be in the open air or in a special building not connected with other departments or with boiler-houses. Pumps should have means for catching escaping oil due to loose packing or blowing off of cylinder-heads. Barrels should be coopered and drums painted in separate buildings. Laboratories, experimental stills, and agitators should be away from other property, and acids handled carefully. Similar precautions should be taken when filling and soldering cans. Smoking should be strictly prohibited. In this connection, employment of a poor class of help will be sure to result in troubles everywhere.

Designing a mosque for the private use of the Sultan of Turkey was the title of the thesis of B. A. Abdulnour, of Beyrout, Syria, a graduate of the Massachusetts Institute of Technology, 1915. The only stipulation in regard to this mosque is that it shall face toward Mecca. The author divided it into two zones, the outer one for the removal of the shoes, while the inner part, reached by a short flight of stairs, is the shrine proper. Around the outside of the mosque the architect has provided pulpits for mollahs.

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European Refining Methods*

By LEOPOLD SEELENFRIED†

Before I enter into my subject I shall define the scope of this paper a little more closely. I shall not speak of European refining methods in the widest sense of the term, but shall restrict myself to Central Europe, that is to the Austro-Hungarian and Rumanian fields. The refining industry in Germany is of relatively small importance and the German crude oil, being somewhat similar in its nature to our California oil, requires different treatment from that of the more important European regions. The greatest oil country of Europe, Russia, is omitted for the reason that its refining industry, though well developed, lacks the variety and interest of the Austrian and Rumanian.

If we accept this geographic limitation we have also narrowed down the scope of our subject to the so-called paraffine-base oil which is the prevailing product in these fields. There are deposits of paraffine-free oil of the highest quality, but the amount is so small as to be unimportant. Therefore, the title of this paper should be 'Methods of Refining Paraffine-Base Crude Oil in Central Europe.'

Even with these restrictions it is impossible to give an exhaustive review of this industry in Europe in the form of a paper, as methods are different in each refinery, just as in this country. There is, however, more uniformity than in this country, for the reason that few companies build their own plants but have this work done by one of a few large engineering corporations which have standardized their apparatus, so that the different refineries resemble each other much more than in this country.

In dealing with this subject I shall not attempt to go into details or to give statistics. Those who are sufficiently interested to pursue the subject further are referred to the work of L. Singer, forming Vol. III of the great work on petroleum edited by Engler and Hoefer. Unfortunately this book is not yet translated into English but I understand from my correspondence with Dr. Singer that a translation will soon appear.

There are some fundamental differences between the refining industry of Europe and that of this country. The initial investment is larger. Rigid factory-inspection laws and strict Government supervision compel the refiner to erect substantial buildings. Frame buildings are absolutely excluded, iron stairs only are permitted, fire-places have to be under cover with suitable quarters for the men, well-paved walks are provided. The wash water is closely inspected before being discharged from the refinery and costly apparatus for its purification is installed. An important feature is the saving of heat by good insulation of pipes and by pre-heaters, which extract heat from the distillates and residues and use it for heating and dehydrating the crude oil before it enters the stills. The exhaust steam is utilized to a great extent to heat water and to furnish heat for the offices and living quarters for the employees, which are provided in most of the refineries. For the same reason the stills are enclosed by brick walls on sides and tops and the bottoms are protected by brick arches.

The continuous system is generally used for distillation of the crude oil. The stills are arranged in batteries of from six to twelve, each still being connected with a pre-heater filled with crude oil, through which the distillate passes in coils. Before the crude oil enters the system it passes through a large vertical pre-heater through which the residue from the last still flows continually. From there the crude oil passes through the different distillate pre-heaters and from the last pre-heater it enters the first still, flows through all the stills and then leaves the system through the large vertical pre-heater as residuum. The distillate pre-heaters as well as the stills are provided with vapor lines and distill off all the gasoline so that by the time the first regular still is reached it is possible to distill part of the kerosene 'fraction.' By regulating the flow of crude oil, each still will produce a definite fraction of constant gravity and by combining the different fractions, products of any desired properties may be obtained. Each still as well as each pre-heater has three vapor-lines so you can readily imagine the variety of combinations possible. This arrangement also makes elaborate receiving houses necessary. These are on the ground and of great length. The receiving tanks are usually situated beside each other in a great pit immediately behind the receiving house. In order to save space they are of prismatic shape.

The products obtained by this primary distillation are crude gasoline, kerosene distillate, an intermediate distillate, paraffine-oil distillate, and residuum, the latter three, of course, containing paraffine. These products are further refined.

The gasoline or crude benzine, as it is called there, is first treated with sulphuric acid and then goes to the benzine plant where it is redistilled in a large, tall rectification-apparatus, provided with a vertical column and similar to the apparatus used for refining alcohol or benzol. The fractions obtained there are, in the order of their gravity, gasoline corresponding to our petroleum ether, two qualities of benzine corresponding to our gasoline, a heavy benzine, principally used for extraction and in the paint industry, and a still-bottom that is used to improve the kerosene.

The kerosene is treated differently from our corre-

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†Pacific Chemical Laboratories, Thayer building, Oakland, California.

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sponding fraction. A re-distillation is seldom necessary. It is cooled down to under 20°C. and treated directly with 3% by weight of sulphuric acid which is applied in two treatments, first a small one of about ½% and then the remainder.

Fractions No. 3 and 4 go to the paraffine-plant where paraffine wax is extracted and then they return to the lubricating plant where they are re-run for the different lubricating distillates. A small part of the paraffine distillate, however, is treated directly before the paraffine is removed and furnishes vaseline. When the oil leaves the paraffine plant it has a cold test of from 0° to 4°C. and is re-run in the reducing stills. While in all distillations highly superheated steam is used, the reducing-stills also run with vacuum. The distillation is similar to the process used in this country. The whole treating plant is installed in a high building, the acid-agitators on top, the alkali-agitators below and the blowing and still discolored and it is first treated with sulphuric acid and soda and then by agitation with fuller's earth. Finally it is filtered and furnishes the different grades of paraffine wax, beginning with the soft match paraffine with a melting point of about 44°C. to the hardest transparent paraffine of a melting point of 60°C. and more.

The latest method of refining paraffine discards the hydraulic presses. The soft crude wax is re-melted and mixed with cold water, whereby it granulates. In this form it is now sprayed into large tanks containing water of the necessary temperature, where the oil and the soft paraffines are removed. This method also makes a further sweating unnecessary. Usually a candle-factory is connected with these plants where paraffine candles and composition candles of paraffine and stearic acid are manufactured. There are no grease or compounding departments at European refineries. These products are manufactured in entirely separate factories.

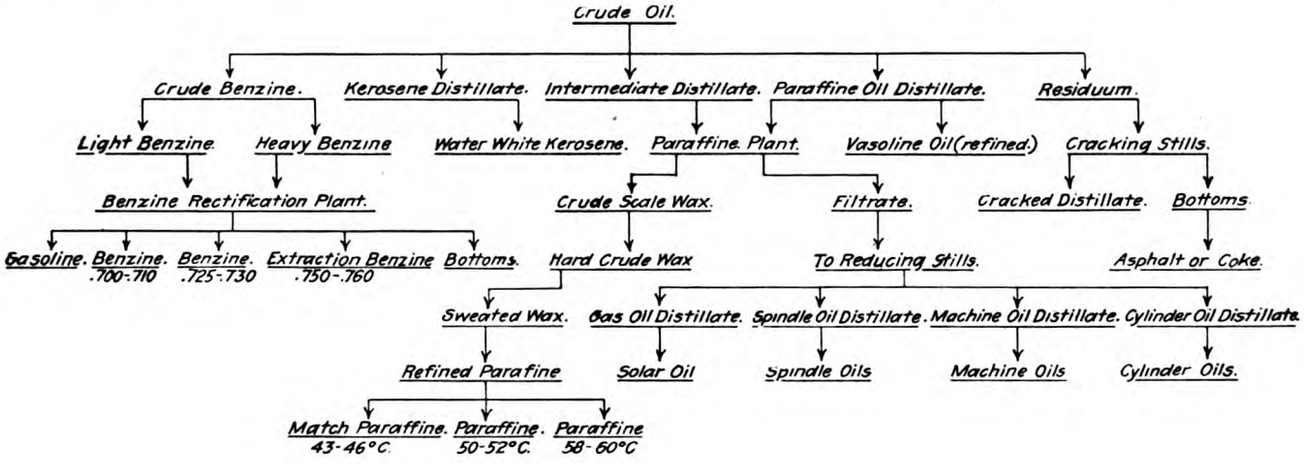

DIAGRAM OF REFINING SYSTEM.

settling-tanks still lower. A smaller amount of acid is used than in this country, about 8 to 12% by weight, applied in three unequal treatments. The European refiners have found it advisable to apply a small amount of strong caustic-soda solution, between the acid and the soda treatment. This helps considerably in the settling of the soda soaps formed during the process. Some also use a small amount of oleic acid to accomplish the same purpose.

The residuum from the reducing-stills goes to the cracking-stills, a process long discarded in this country, at least in this form. These stills are vertical, of heavy cast-iron with specially heavy bottoms made of one piece and are provided with a mechanical stirring apparatus. The products obtained here are lighter distillate which is re-run and used for various purposes in the refinery, and the different grades of asphaltum beginning with the softest, called *goudron*, down to the hardest asphalt.

The paraffine-plant is the most interesting of the different departments. The cooled oil goes to filter-presses, the soft crude paraffine which still contains considerable oil is further pressed in large hydraulic presses and then goes to the sweating-rooms, where the rest of the oil is removed by steam-heat. The paraffine is now hard but

These are the principal departments of a refinery proper. Of course, much attention is given to the recovery of by-products, especially acid, but this latter department is not so efficient as in the great American refineries. However, they only attempt to recover black acid having a gravity of about 52° Baumé, which finds a ready market in the fertilizer factories.

Impact resulting from flat spots on car-wheels and its effect is being investigated by the mechanical engineering department of Purdue University, Lafayette, Indiana. These tests cover flat spots of various sizes on wheels carrying fixed loads and running at definite speeds. It has been found that an imperfect wheel with a 3-in. flat spot strikes the track with an impact of 104,000 lb. when the car is going 16 miles per hour and is carrying a load of 20,000 lb. It was also found that under similar conditions a flat spot only 1½ in. long produced a blow of 20,000 lb., and the impact for spots 2 in. long was 25,000 lb. A standard freight car was mounted in the test-laboratory, and special apparatus, including an instrument which recorded photographically the magnitude of the blows, was employed.—*Mechanical World.*

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A Rational Basis for Motor Gasoline Specifications*

The manufacture of gasoline motors has now been so thoroughly standardized that we may safely eliminate from consideration all unusual devices, such, for instance, as fuel-injection or crank-case compression, and assume that practically all motor gasoline is consumed in multi-cylinder, high-speed, four-stroke cycle engines, having only moderate compression; and that the fuel is introduced into the engine through air-actuated spray-carburetors at or near normal air temperature.

Many tests have been proposed for gasoline, these falling into two classes, purity tests, and distillation or evaporation tests for volatility. It is impossible here to enter into a discussion of different methods, and I will confine myself to the briefest possible description of a test which can be used as a check on each specification clause. The latter are given below, in the order of their importance, with the test following each.

A. The gasoline shall be free from water, in drops or as a cloud, and from any suspended solids.

Test: None required, as such impurities are readily visible. The drainings from drums, tanks or cars in which gasoline is shipped should be examined from time to time.

B. The initial boiling point of the gasoline shall not be lower than 80°F.

Test: This figure is determined at the beginning of the distillation test, to be given later.

C. The vapor pressure of the gasoline at 100°F. shall not exceed 10 lb. per square inch.

Test: Enclose 50 to 100 c.c. of the gasoline in a brass cylinder having a capacity about 5% greater than the volume of the sample taken. Screw tightly into the top of this cylinder a sensitive Bourdon spring-gauge (inspector's test-gauge). Immerse the cylinder and the lower portion of gauge in water at exactly 100°F., and allow to stand twenty minutes. Tap the gauge lightly to be sure that needle is free, and read pressure.

D. The gasoline shall leave no residue of tarry or solid matter when evaporated in contact with a heated surface.

Test: The lower portion of the test flask used in the distillation test given later should be used as a gauge. If this is perfectly clear at the end of the distillation the result would be recorded as perfect, a yellow stain would be recorded as good, any stain darker than No. 5 color on the N. P. A. color-scale (a deep amber) would be poor, while a brownish-black or black stain, or any deposit which separates from the glass in scales, would be cause for rejection of the sample.

E. The gasoline shall not absorb oxygen nor form tarry products when oxidized.

Test: The proper test for instability to heated air is to heat a sample under pressure sufficient to retain the vapors, to about 400°F., and note any serious discoloration of the gasoline. This test is quite out of the question in a working laboratory.

Instability toward heated air is due to the presence of unsaturated bodies, which may be determined directly. The following test should be used. Shake 100 c.c. of the gasoline with 10 c.c. of chemically pure, water-white, 94% sulphuric acid, in a stoppered graduated cylinder. Allow the acid layer to settle for four hours. If the acid has become so dark that fine print cannot be read through a ½-in. layer, or if the volume of the acid has increased more than 2 c.c. the sample should be rejected.

F. The gasoline shall be water-white and shall be free from any offensive odor.

Test: None required, a proper judgment of color and odor depending solely on experience.

All the requirements noted above are such as can be rigidly applied, samples not conforming to them being unfit for use in high-grade heat-engines. The requirements given below are such as could be applied by purchasers, either as they stand or with a change in the limit figures, but I would not consider them justifiable as public-inspection requirements.

G. The highest calorific value will, other things being equal, be given the preference in the purchase of gasoline.

Test: Determine in the oxygen bomb, in the usual manner.

H. The vapor tension at 100°F. shall be not less than 2 pounds per square inch, and higher vapor tensions, up to 10 pounds per square inch will be preferred.

Test: Refer to description given under Clause *C.*

I. The initial boiling point of the gasoline, as determined in the test given below, shall not be higher than 120° Fahrenheit.

J. The proportion distilling below 150°F. shall be not lower than 5% of the sample, and a higher proportion will be preferred.

K. The proportion distilling below 200°F. shall be not less than 30% of the whole.

L. The proportion distilling below 250°F. shall be not less than 60% of the whole.

M. For every 1% by weight remaining undistilled at 300°F., not less than 1% shall distil below 200°F., and not less than 2% below 250° Fahrenheit.

N. The boiling point when the last drop leaves the flask shall be not over 400° Fahrenheit.

Test: The ordinary distillation tests, which prescribe Engler flasks, are highly deficient when applied to gasoline, and in particular to such as contains much volatile matter. The condensing arrangements which it is feasible to use in regular laboratory work cannot condense the lighter portions of the gasoline, and as the amount

*Abstract from paper prepared for the American Petroleum Society meeting in San Francisco, October 1915, by Paul W. Prutzman, consulting petroleum engineer.

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distilled off must be measured by the amount collected in the receiver, there is always an error, which is variable for different operators, and under differing conditions. I would therefore suggest a method of distillation in which all readings are made on the residue and all cuts guided by temperature only.

An Engler flask of standard dimensions is equipped with a thermometer in the usual manner, but is connected to the condenser or to a waste-tube by means of a short piece of heavy pure-gum tubing, the two glass parts being brought end to end inside this section. The apparatus is set on wire gauze over a burner in the usual manner. The thermometer bulb being brought opposite the vapor outlet, as is customary in these distillations, the flask is charged with 100 grams of the gasoline to be tested, and heated until the vapors begin to condense in the side neck, when the boiling point is read.

Heating is then continued until the thermometer reads 150°, when the fire is withdrawn, the flask allowed to cool a few degrees, the rubber connection broken, leaving the rubber on the flask, and closing it against loss of vapors with a spring clamp. The flask is then set on the balance pan, supported safely, and weighed. The tare weight of flask, tube, thermometer and clip, previously determined, is added to the weight of gasoline taken, the last weight deducted, and the loss in grams noted. The flask is then attached again to the condenser, the burner lighted, and the temperature raised to 200°F., when the weighing process is repeated. Readings are thus taken at 250° and 300°, and finally the temperature is noted at which the bottom of the flask just becomes dry. The flask is then cooled, and rinsed out with fresh gasoline before noting the color of bottom, as required by Clause *D*.

This method of working eliminates all errors due to imperfect condensation, and the results can be duplicated closely if standard proportions of apparatus† are followed. It is not suited to making 'cuts' into equal volumes.

WOOD-BLOCK PAVING IN GREAT BRITAIN

Wood-block paving is in general use in nearly all of the several hundred boroughs of the United Kingdom whose population is greater than 60,000. Its growing popularity is due to the fact that it shows a longer life under motor-bus traffic than any other smooth pavement that has yet been produced at equal expense, to the ease with which repairs may be made, and to the absence of dust and noise. There are a few prominent cities, such as Glasgow, Dublin, Belfast, and Liverpool, where wood-block paving is not used except in front of hospitals and schools. In these cities granite sets are employed and their displacement by wood pavements is delayed because of the practice of shoeing draft horses with sharp calks, which tear up the wood blocks.

†See Holde's 'Examination of Hydrocarbon Oils,' 1st American edition, p. 27.

Many woods have been tried for pavements. Jarrah was introduced, but proved unsatisfactory, wearing and breaking off at the corners and edges and producing a rutty pavement. Red gum from the United States likewise gave poor service. The use of oak was discontinued some 12 years ago on the ground of expense. Pitch pine from the United States was also tried, but it did not wear evenly and produced a rough pavement. Canadian white spruce was laid on the north side of Trafalgar Square in London 12 years ago with an 8 lb. treatment of creosote per cu. ft. and is still in excellent condition. Without exception, the wood-block pavement laid in Great Britain now is Swedish and Russian redwood (*Pinus sylvestris*). The specifications issued by the municipal engineers throughout the country admit this wood and no other, the one exception being the specification for the borough of Westminster, London, which admits Canadian spruce, red pine, or Douglas fir.

Swedish redwood has three points in its favor: the price is satisfactory, its life is definitely known, and the paving companies handle it. In normal times Swedish and Russian redwood was delivered in 3 by 8 or 3 by 9-in. pieces, 6 to 20 ft. long, averaging 16 ft., dressed one side and one edge, for $25 to $28 per thousand feet B.M. c.i.f. The price has risen during the War to $41. This timber, sawed into 4-in. blocks and given an 8 to 10 lb. treatment of creosote, will make a pavement lasting 20 years under light traffic in London and 12 years under heavy traffic.

Only a few important municipalities purchase blocks or lay pavements. Nearly all the paving is done by companies, which contract with the municipalities to manufacture the blocks, creosote them according to specifications, lay the pavement on the base prepared by the municipality, and maintain it free of cost for an agreed annual charge per square yard for a stated term of years. The cost of this service ranges from $2.20 per sq. yd. for a 4-inch block with an 8-lb. treatment to $3.40 for a 5-in. block with a 12-lb. treatment. The cost of laying is 4c. per sq. yd. The cost of maintenance, where the maintenance is undertaken by the municipality, is 20c. per sq. yd. per year. Creosote costs 6c. per gallon at the works in England.

Under the English specifications for blocks, hearts are admitted; also knots, unless loose or on the upper end of the block, and are sometimes accepted even then. There is no rigid adherence to any rule regarding the rate of growth. The Russian redwood is preferred to the Swedish because it is slower growing and therefore harder, but blocks are admitted with rings six or even four to the inch. There is no rigid exclusion of sapwood, some specifications admitting as much as 18% of 'saps.' The quantity of timber used in Great Britain for paving in 1913 was approximately 60,000,000 feet.

A 30-in. lathe with a 100-ft. bed is described in a recent number of *Mechanical World*. The lathe will admit 89 ft. between centres. Spindle speeds between 1 and 83 revolutions per minute are obtained.

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The Use of Hydrated Lime in Concrete for Waterproofing

By L. N. WHITCRAFT*

Hydrated lime used in cement mortar and concrete produces increased plasticity, reduces the tendency toward segregation to a minimum, and increases the density and uniformity. Increased plasticity facilitates the mixing, handling, and placing. Less segregation results in a denser and stronger concrete of greater uniformity and impermeability. Greater density and uniformity decreases the permeability, makes the concrete more durable and waterproof, and reduces the expansion and contraction under moisture changes, thereby reducing internal strains and stresses that frequently cause cracking.

The Bureau of Standards, Washington, D. C., has made elaborate tests covering practically all compounds which have been recommended for waterproofing cement mortars and concretes. These tests are described and the results given in Technologic Paper No. 3. On page 59 of this paper the following statement is made:

"Hydrated lime is the most efficient medium employed and resulted in an almost impermeable mortar at the two-week test. Its value is probably due to its void filling properties."

In view of the results obtained by the Bureau of Standards, it seems probable that all concrete work would be improved by the addition to the cement of from 10 to 15% by weight of hydrated lime, and that its use would help in securing a more waterproof concrete. One point should, however, be borne in mind by all engineers and contractors, namely, no waterproofing material will compensate for improperly proportioned aggregate and poor workmanship, and that the aggregate should be as carefully selected as the cement and the waterproofing material.

Sanford E. Thompson in a paper read before the American Society for Testing Materials in June 1908, described a series of experiments on the effects of hydrated lime on concrete. His conclusions from these experiments were that hydrated lime increases the water-tightness of concrete and that the effective proportions of hydrated lime for water-tight concrete are as follows: 8% for a 1:2:4 mixture, 12% for 1:2½:4½ mixture, and 16% for a 1:3:5 mixture. The proportion of the weight of the dry hydrated lime to the weight of the dry portland cement is given in each case.

Mr. Thompson also concluded that the cost of waterproof concrete structures may frequently be reduced by employing leaner proportions of concrete with the addition of hydrated lime and that lime paste made from a given weight of hydrated lime occupies about 2¼ times the bulk of paste made from the same weight of portland cement, and is therefore useful for filling voids.

The proper proportion of lime to be used will vary considerably with the character of the aggregate, but the figures given represent a fair average. Coarser sand would naturally require a slightly larger proportion of lime, and finer sand, that is, sand having a larger percentage of fine grains, would probably require less lime since sands containing considerable fine material produce a more water-tight, although a weaker concrete.

In another place Mr. Thompson describes the results obtained for the concrete used for the Waltham reservoir as follows:

"A few permeability tests of specimens made with the addition of hydrated lime performed by me in 1903 indicated it to be a valuable material for waterproofing. Later in 1906 when the reservoir at Waltham, Massachusetts, which is 100 ft. in diameter and 43 ft. high, was under consideration, I was consulted by Bertram Brewer, city engineer, in the framing of the specifications and made a series of tests as follows:

"Permeability test of 1:2:4 concrete for Waltham, Massachusetts, reservoir, in 1906. Concrete 4 in. thick. Pressure 80 lb. per square inch.

Hydrated lime, %	Flow in grams per minute. At 14 days.	At 21 days.	At 28 days.
0	5.52	2.92	1.91
2	9.20	2.55	1.63
4	2.82	1.49	0.76

"The proportion of lime is expressed in terms of the weight of cement.

"As a result of these tests 5% of hydrated lime was adopted for the reservoir to mix with the 1:2:4 concrete in building its walls. The results were satisfactory, the only seepage occurring at joints formed between different day's work, where the bond between the old and the new concrete was not made with sufficient care."

As has been already stated the quantity of lime that should be used depends upon the fineness of the sand employed and the proportions of the mixture. The concrete materials must be properly graded. Even with this preliminary care, if the concrete is poorly mixed with insufficient water, or improperly placed, or if joints are left, the walls will inevitably leak. The mixing must be thorough and sufficient water must be employed to give a 'mushy' mixture so that it will settle into place with the least amount of ramming. Fully as important as care in mixing is the bonding of one day's concrete with the next. On a hot day even interruptions of an hour will materially affect the bond of the concrete. Hydrated lime can be used advantageously only with mixtures as lean or leaner than 1:2:4 unless the lime is substituted for an equal weight of cement.

*Oliver Bdg., Pittsburgh, Pennsylvania.

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Discrepancies Between Map and Text in a Geological Survey Report

By LEON J. PEPPERBERG*

The value of the publications of the U. S. Geological Survey is appreciated more each day by the general public as well as by the professional men interested in the development of mineral properties. That these publications direct prospecting along certain lines is beyond question.

Being a former member of the Survey, I know that oftentimes reconnaissance examinations which form the basis of reports are done under adverse circumstances, consequently hasty examinations sometimes lead to the publication of reports which are shown by later detailed work to be in part erroneous. Most of such errors are excusable. However, the fact that reports written by Survey members are discussed with the departmental chiefs and subjected to the 'acid test' by an editorial staff before publication should give a certain surety that the data presented in the text coincides with the maps accompanying the report. Many of the reports are issued while the authors are in the field, but usually the final galley-proof is submitted to them before publication. The question then arises as to whether the author or the administration is at fault when marked discrepancies occur between the text of a report and the accompanying map.

Being conversant with the conditions under which the Survey's investigations are made, I have defended Survey publications and policies on numerous occasions and in many instances have furnished information concerning certain districts to members of the Survey. Fully appreciative of the valuable data published by the Survey and having the good of that institution at heart, I hope that the present discussion will have influence in raising the standard of accuracy in future publications to the level which the importance of the information obtained by the investigations warrants.

The use of structure-contour maps to show the geological structure of a district is common, especially in depicting the structure of oilfields. When such maps are properly drawn, the geological structure of the district is as clear to one accustomed to reading them as it would be if a model showing the structure were before him.

During June 1915, while engaged in private investigations, I had occasion to make a hasty examination of several portions of Palo Pinto county, Texas. The results of this investigation so far as the structure of the district is concerned coincides with the text of the Survey bulletin[1] issued in September 1915. A portion of the text of this bulletin is as follows:

Stratigraphy. * * * "Of the several escarpments which cross Palo Pinto county from northeast to southwest and are formed by the outcropping edges of sandstone and limestone strata, three are particularly prominent: the one just described, formed by the basal limestone of the Canyon formation; a second, of which Kyle and Wolf mountains are a part and which is formed by a limestone bed 400 ft. above the base of the Canyon formation; and a third, which lies north of the Texas & Pacific railroad, between Brazos and Gordon, and is formed by a sandstone of the Strawn formation, a little above the Thurber coal bed. In tracing these three escarpments from northeast to southwest across the county they appear to converge, as if the dip of the rock strata increased slightly in that direction. * * *

Methods of Field Work. "Geologic observations to determine structure were confined in the present examination to the limestone bed which forms the second of the escarpments just mentioned and which is well exposed in Kyle mountain, north of Palo Pinto. By a system of plane-table triangulation, together with vertical angles read with a telescopic alidade, numerous elevations were taken on the top of this limestone bed at intervals along the escarpment for a distance of 16 miles. From these observations it has been possible to make a structure contour map of the surface of this limestone, showing the shape of the folds into which it has been thrown and the relations of these folds to the gas-seeps and gas-wells in the region.

Interpretation of Structure Contours. "The structure contours given in Fig. 5 are drawn upon the surface of the 50-ft. limestone bed and represent the folded surface of that bed as it was before parts of it were removed by the action of streams. Every point along any one contour line is at the same elevation above or below sea-level, and the lines are drawn to show differences of 20 ft. in elevation.

"To one unfamiliar with the interpretation of structure contours the following somewhat fanciful conception may be of assistance. Were it possible to remove all of the overlying strata and to walk about on the upper surface of the limestone bed the course followed by on who endeavored to walk always at an elevation of, say, 1200 ft. above the sea, never stepping up or down, would be that indicated by the 1200-ft. contour on the map. A series of lines drawn at regular intervals above sea-level will indicate clearly, to one accustomed to the reading of contours, the form of the surface represented by them.

Structure. "The dominant structure in north-central Texas west of the Cretaceous area is a monocline in which the beds dip toward the northwest at the rate of 40 to 50 ft. to the mile. Superimposed upon this

*Consulting geologist, 651 Howard street, San Francisco.

[1]U. S. Geological Survey, Bulletin 621-E. 'Reconnaissance in Palo Pinto County, Texas, with Special Reference to Oil and Gas,' by Carroll H. Wegemann, p. 55-58.

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monocline there are, in certain localities, small cross-folds, the axes of which trend in a northwesterly direction, at right angles to the prevailing strike of the rocks. It is these cross-folds which appear to have been the chief factor in determining the places of accumulation of oil and gas. The principal cross-fold in the part of Palo Pinto county which was examined in greatest detail in the present work is in the vicinity of Kyle mountain, four miles north of the town of Palo Pinto. Kyle mountain is about two miles southeast of the main line of the escarpment, and the limestone bed which caps it is evidently the same as that forming the escarpment. There is, however, little difference in altitude between the thick limestone bed of Kyle mountain and that of the main escarpment, whereas if the normal dip prevailed at this locality, the bed on Kyle mountain should be at least 100 ft. above that on the escarpment. There is at this locality, therefore, a flattening of dip such as is found in many places along the axes of cross-folds. The presence of a cross-fold is demonstrated also by other observations taken along the line of the escarpment.

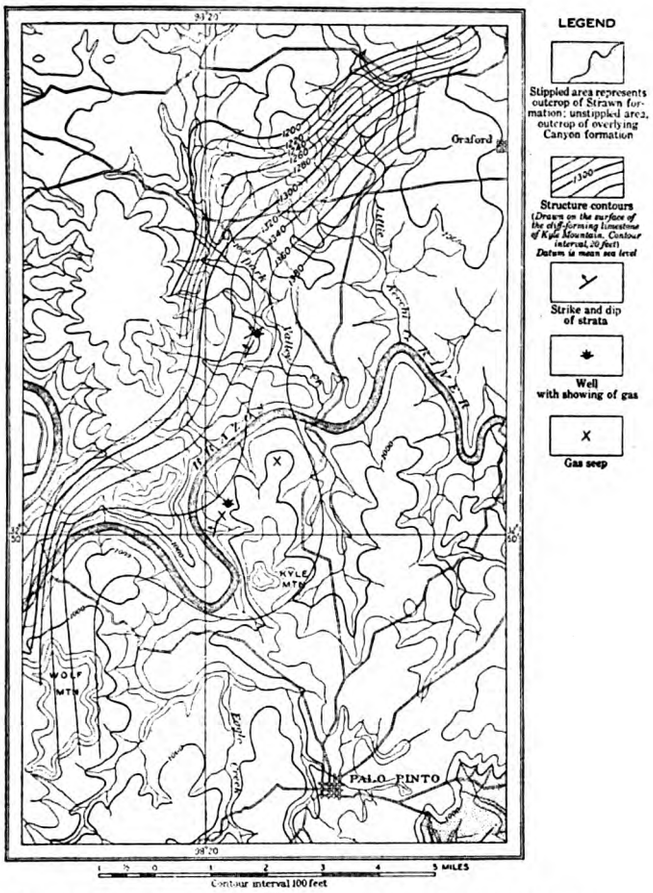

FIG. 5. MAP OF ANTICLINAL STRUCTURE NORTH OF PALO PINTO, TEXAS. (FROM GEOLOGICAL SURVEY REPORT.)

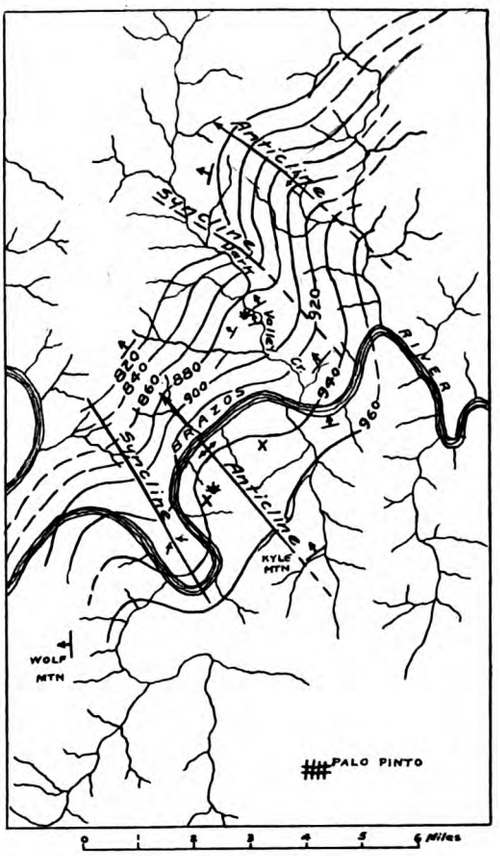

FIG. 6. CORRECTED MAP OF SAME AREA.

"The gas seep on the Dalton ranch, one mile northwest of Kyle mountain, is nearly on the axis of this fold, which extends in a northwesterly direction. (See Fig. 5.) The old well on Dark Valley creek, one mile above its mouth, is situated on the flank of the fold. From dip and strike readings taken on the limestone bed exposed near the old well there appears to be at this locality a small local roll on the side of the larger structure. This small roll may account for the gas found in the well. The prominent hill, four miles due north of the bridge over Brazos river and four miles west and a little south of Graford, appears to be on the axis of another and smaller anticline. The beds at the southeast end of this hill dip to the northwest, but a mile farther west the strike changes until the beds dip to the southwest, as if this anticline were separated from that of Kyle mountain by a shallow syncline whose axis lies a little northeast of Dark Valley creek. (See Fig. 5.) In Wolf mountain the strike of the beds appears to be approximately north, Wolf mountain being separated from the Kyle mountain fold by a shallow syncline. How far the Kyle mountain fold extends toward the southeast has not been determined, but it is probable that a minor fold of this nature would not extend for any great distance.

"Details of structure were not worked out in other parts of the area. The gas wells in the Thurber field, three miles southwest of Strawn, appear to be on a small dome or anticline, as is shown by a comparison of the logs of the wells."

Fig. 6 shows the structure contours of the district just described as I have worked it out. These contours

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are based on a lower datum than that used by the Survey, consequently the elevations given are not the same on both maps. A comparison of the two maps with the text of the Survey bulletin shows that the Survey map (Fig. 5) indicates synclinal structure where the text describes anticlinal structure, and vice-versa, while my map indicates the structure described in the text of the Survey bulletin and which coincides with conditions found in the field.

In an economic report the map is more important than the text because it forms the foundation upon which the report is based and should represent the conditions found and recorded in the field. The reason attention is called to the marked discrepancy between the text and the map of the Survey's bulletin is that maps are depended upon to show field conditions and are usually separated from the text and taken to the field as a guide by investigating engineers whose time is necessarily limited when compared with the time spent in the same region by the geologists of the Survey.

THE ORIGIN OF PETROLEUM AND ASPHALT*

By CLIFFORD RICHARDSON†

Of the many theories proposed to explain the origin of petroleum none appears to me to be satisfactory or to be sustained by the evidence offered in support of them. With the recent extension of our comprehension of the relation and behavior of surfaces and films as the result of discoveries in the field of colloidal chemistry and of the phenomena of adsorption connected with surfaces, a new theory has been advanced regarding the origin of the liquid and solid forms of native bitumen. In the study of bitumen and colloidal matter it was recognized that the origin of the more or less solid bitumen, which forms the asphalt of the Island of Trinidad might be attributed to the conversion of a heavy petroleum into asphalt by the surface action of a colloidal clay upon the soft bitumen, as described in the papers cited.‡ It was shown to be possible that the heavy petroleum rising from the oil sands through a paste of colloidal clay and water, was emulsified by the violent action of escaping natural gas and this emulsion of oil and colloidal material was converted, after reaching the surface, into a solid asphalt.

In view of this phenomenon, in which the action of colloidal material on petroleum is so plainly demonstrated, it seems to me that the origin of all forms of petroleum should be attributed to similar surface action between a natural gas and 'sands,' using this term in a general sense, with which it comes in contact. The character of petroleum formed in this way will be dependent on two conditions: the nature of the gas itself and that of the 'sand.' If the gas contains sulphur, a sulphur petroleum will be formed. Again, its character will depend largely on that of the 'sands' with which the gas comes in contact. If these contain sulphur, a kind of petroleum will result which may be quite different from that originating in a gas containing sulphur. This might explain the difference between a Trinidad and a Mexican petroleum in which the sulphur is present in different forms. If the sand is of a colloidal nature and consequently more active, asphaltic petroleum will be formed, whereas if it is more nearly a true sand, with less surface action, oil of a paraffine nature may result.

It seems that the phenomena of surfaces and films, as shown by the recent developments of colloidal chemistry, open up an entirely new point of view for the interpretation of the origin of petroleum and asphalt and one which, no doubt, will be widely developed in the future. In presenting this theory of the formation of petroleum in its different types, it is unnecessary to carry the theory further back than the change which takes place in a natural gas, and to leave the question of the origin of natural gas to other investigators.

To those who are interested in the phenomena connected with colloidal matter and adsorption, a study of the subject as given in 'The Chemistry of Colloids,' by W. W. Taylor, Longmans, Green & Co., New York, is recommended.

*Paper presented at the meeting of the American Petroleum Society, San Francisco, October 1915.

†Consulting engineer, New York City.

‡'A Unique Geophysical Phenomenon, Trinidad Asphalt, Interesting from the Point of View of Dispersoid Chemistry,' *Journal of Physical Chemistry*, Vol. 19, No. 3, 1915, and 'The Theory of the Perfect Sheet Asphalt Surface,' *Journal of Industrial & Engineering Chemistry*, Vol. 7, No. 6, 1915.

RESULTS OF MAGNETIC SURVEY OF UNITED STATES

Observations have been made at more than 1000 new stations and 200 repeat stations since the publication in 1910 by the United States Coast and Geodetic Survey of a report containing its isogonic chart, based upon the magnetic survey of the United States which was begun in 1899. The results are given in Special Publication No. 33, Serial No. 18, of the Survey, on: 'Terrestrial Magnetism—Distribution of the Magnetic Declination in the United States for January 1, 1915, with Isogonic Chart and Secular Change Tables.' The plan for this work contemplated, first, a general magnetic survey of the country, with stations 30 or 40 miles apart, and, second, the addition of more stations in magnetically disturbed areas. It also provided for observations at a sufficient number of repeat stations to determine the change in the magnetic elements from year to year. The work has now advanced to the point where observations have been made at a great majority of the county seats, and the examination of areas of marked local disturbance is in progress. The isogonic chart is a map on which lines are drawn through places at which the values of the magnetic declination are the same. The present chart is based on about 6000 values of declination, including about 800 in Canada and 300 in Mexico and the West Indies. This chart is also published separately, on heavier paper, for the use of those who do not need Special Publication No. 33.

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Methods and Costs of Construction of Concrete Highway at Sarnia, Ontario

An account of concrete-road construction at Sarnia, Ontario, taken from a Provincial Government report prepared under the direction of W. A. McLean, commissioner of highways for Ontario, appears in *The Canadian Engineer.*

The road was 5946 ft. long; the pavement being 16 ft. wide and 7 in. thick, with gravel shoulders 4 ft. wide on each side. The work was carried out in accordance with the specifications for concrete roads contained in the report of the Ontario Office of Public Roads for the year 1913. The mixture was 1 part cement (of which 10% by volume was hydrated lime) to 4 parts gravel, laid in one course. The road before improvement was unmetalled, flat, and undrained. The method of construction was as follows:

Grade stakes having been placed by the engineer down the centre and along the sides of the road, the earthwork was commenced. The sod was ploughed and moved to the side of the road with drag scrapers. The open gutters on the side of the pavement were then formed by ploughing and scraping the earth into the centre of the road. This earth being free from humus was suitable for raising the subgrade, which had been lowered by removing the surface sod. As soon as the gutters had been roughly formed and the earth disposed as described, the road roller was put at work compacting the earth base. Each time the roller passed over the whole subgrade, the road grader followed to remove irregularities from the edge of the subgrade, which tended to fall away under the weight of the roller.

Meanwhile a contract had been let for laying tile along both sides of the road with a tiling machine. The machine straddled the gutter, beneath which the trench was excavated, and the tile was laid about 3 ft. below the surface, as nearly as grade would permit. The price for this work was 50c. per rod, which was cheaper than hand-work, and in addition much better results were obtained.

As soon as the subgrade on the most distant portion of the work had been prepared, enough gravel was deposited on the road to provide sufficient surplus for a thin layer between the subgrade and the concrete, and also to cover and protect the newly-laid concrete. The gravel used on the work was supplied from the St. Clair river at Point Edward and was delivered by scows operating with a clam-shell bucket. The price paid was 45c. per cu. yd., delivered on the dock. A storehouse was built at a convenient spot on the side of the road, to store cement and lime.

When sufficient gravel had been hauled to keep the concrete-mixer going for two weeks, a gasoline concrete-mixer was placed in front of the storehouse, and a large concrete-pavement mixer was moved to the road. The gasoline-mixer was used to mix the cement and hydrated lime. It was operated by seven men and a foreman who also ran the engine. The lime was kept in the storehouse and the cement was hauled from the car directly to the machine, where it was mixed with the lime, resacked and either placed in the storehouse to be kept as a reserve supply, or hauled directly to the concrete-mixer. Ordinarily a car of cement was mixed with the necessary lime in a day and a half.

Ordinarily one team and 20 men, in addition to the engineer, were required to operate the mixer. The men were arranged as follows: 1 superintendent, 1 foreman, 1 team delivering cement-lime mixture, 1 man handling cement at mixer, 8 gravel shovelers, 2 men wheeling gravel to mixer, 1 engineer, 1 fireman, 1 man dumping bucket, 2 men shoveling concrete and operating first template, 2 concrete finishers, 2 extra men for watering concrete, removing forms, greasing expansion-joint strips, and covering concrete with gravel. Two concrete finishers also operated the box template and set the wooden strips for concrete-forms.

Stakes 25 ft. apart were driven to line and grade daily by the engineer in charge. Lines were stretched on the top of these stakes by the finishers, and intermediate stakes approximately four feet apart were driven to hold the wooden strips in place. As the concrete hardened, it was covered with the excess gravel that had been hauled for the purpose, and shoveled outside of the concrete forms. This gravel was kept damp and protected the concrete from the hot sun, preventing it from drying out too rapidly.

When the concreting was finished and the concrete had been allowed from ten days to two weeks to set, the gravel covering was shoveled off and the expansion joints, which were 30 ft. apart, were cleaned. The joints were then half filled with building sand and the remainder filled to overflowing with paving pitch. A portable tar kettle was used to heat the pitch which was applied with a cone-shaped ladle with a ½-in. runner at the bottom. This runner could be regulated by a plug at the end of an iron rod leading up to the handle of the ladle.

The wages paid were as follows:

Foreman, per day	$2.50 to $4.00
Engineers, per hour	0.40
Laborers, per hour	0.25
Teams, per hour	0.55

The unit cost per square yard of pavement was as follows: Grading and ditching, $0.155; mixing lime and cement, $0.084; hydrated lime, $0.022; cement, $0.367; gravel, $0.294; labor on concrete, $0.200; expansion joints, $0.011; drainage, $0.111; gravel shoulders, $0.187; supervision, $0.057; tools and sundries, $0.054; total, $1.542.

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Notes on the Santa Maria Oilfields*

By PAUL W. PRUTZMAN†

The Santa Maria-Lompoc oilfield is situated at the western end of Santa Barbara county, and includes four sub-fields, namely, the Cat Canyon or east field, the Santa Maria or old field, the Casmalia, and the Purissima field. The Santa Maria field proper is due south of the town of Santa Maria, at the western end of a range of hills running east and west. Cat canyon is several miles farther east on the same ridge. Casmalia is due west of the old field, but in a range of hills running north and south, parallel to the coast. Lompoc (or Purissima) is due north of the town of Lompoc, on the south exposure of a ridge parallel to that on which the old field and Cat Canyon wells are situated.

The Cat Canyon field includes two groups of wells, only a short distance apart, but of rather different character. The wells in Cat canyon proper are in the neighborhood of 3000 ft. deep, and produce a heavy oil, ranging from 14° down to 10° Baumé, from incoherent sand. Several wells have been productive and a number of encouraging prospect-holes have been drilled, but water-troubles have been encountered from the first, and the difficulties of operation, combined with the low price and small demand for this heavy oil, have had a restraining effect on development. The field is now practically shut down, only two or three wells being on the pump at last reports. It can hardly be doubted that there is considerable oil available here when an advance in price warrants its development and production. The oil from this field is practically identical with that produced by the next group.

In the Blochman group of the Cat Canyon field are about twenty producing wells, some of which have in the past produced large amounts of oil. Three of the Palmer wells, formerly gushers producing thousands of barrels daily, are now about dormant, the Union wells on the Bell tract are producing small amounts on the beam, the Dome wells are steady but not large producers, and the Palmer Annex wells are also in the small-producer class, though lately a well flowing a thousand barrels per day or better was completed. On account of the limited demand for crude-oil of this class the wells in this field have been restrained as far as possible for the last two years, and the production could be increased considerably without new drilling.

Prospecting has been done on all four sides of this field, with varying results. To the east, water was found in place of oil, and while there is some unproved territory, there does not appear to be much chance in this direction. The Pinal-Dome Oil Co. is now drilling a prospect well to the southwest, though farther in this direction there are several deep dry holes. To the north, several test holes have been drilled, none of which are now productive, though some showed oil in encouraging quantities, and might have been made producers with better fortune in drilling, which is difficult in this territory. The wells are not unusually deep, about 2800 ft., as a rule, but sand and water above the oil-sands are hard to handle. It is probable that considerable new territory will ultimately be added to this group.

The oil from the Blochman group of wells ranges from 12 to 15° in gravity, and is characterized by large proportions of asphalt, a high sulphur content, and an unusually large amount of light distillate for such a heavy oil. Most of the crude oil now used goes to the making of road oils, for which it is peculiarly suited because of the large proportion of asphalt, and the great tenacity and adhesiveness of the product. A considerable amount is used in the manufacture of asphalt. The Palmer oil goes mainly to the California Liquid Asphalt refinery at Hadley, 30 miles away, where is also situated the Ensign-Baker refinery, now closed. The Palmer Annex company has a trumble road-oil plant on its lease, with rail connections to Guadalupe. The Pinal-Dome company ships by rail to its refinery for making road oils and asphalt at Betteravia, while the Union and the Associated companies have pipe-line connection with Avila and Gaviota respectively.

In the old field there is a large number of wells, ranging from 2800 to 3600 ft. in depth, and producing oil ranging from 20 to 32° in gravity. A few of these wells were formerly large gushers, but these have long since settled down to the status of steady producers on the pump. This field is suffering the slow diminution common in wells of this age (8 to 13 years) though the total production of the field has been maintained by a little new drilling and considerable deepening of old wells.

At one time water made serious inroads on the production, and it was feared that the end of the field was near. The source of this trouble was finally discovered, and the water shut out so effectively that not only were further encroachments stopped, but most of the lost production was also recovered. There now appears to be no danger on this score.

The boundaries of this field are marked by a continuous line of dry holes, except on the south, and it is likely that there is little new territory available Search for a deeper sand toward the northwest of the field brought no results, but a prolific deeper sand was

*Paper prepared for the meeting of the American Petroleum Society, San Francisco, October 1915.

†Consulting petroleum engineer, San Francisco.

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found toward the centre of the field, and what appears to be the same sand has lately been penetrated in wells toward the southern margin. As the oil found in this sand is the lightest and best yet discovered, it is probable that the output of the field will be maintained, in both quantity and quality, for some time to come.

The Santa Maria light oil is characterized by its high gasoline content, and by the large proportion of asphalt considering the gravity. This oil also contains much paraffine in the heavier fractions. All of it is refined, mainly by the Union Oil Co. at Avila, by the Associated company at Gaviota, by the Western Union and the Treasure companies at small plants in the field, and by the Pinal Dome company at Betteravia, ten miles northwest of the field.

Much gas is produced in this field, all of it being rich in gasoline. Practically all this gas is 'stripped,' by the New Penn company on its own property, by the Purity Gasoline Co. on the Rice ranch, by the American Gasoline Co. on the Brookshire property, by the Union Oil Co. in a large plant on the Newlove property, and by the Pinal Dome company in a moderate sized Bessemer plant on the Dome tract, and in a large steam plant on the Pinal property. The gasoline thus produced, which is of high gravity and extreme purity, adds materially to the casing-head gasoline output of the state.

At Casmalia there is a group of three or four producers of heavy viscous oil that has been idle for some time, though they are now being prepared for production for the manufacture of road oil. Several prospects in this territory gave encouraging results, and as some new wells are now being drilled, there will probably be a material production here as fast as conditions warrant its development. This oil closely resembles the Cat Canyon oil both in properties and usefulness.

In the Lompoc field there are a dozen or fifteen wells scattered over a wide range of territory. Except toward the west, where several dry holes were drilled, and to the southeast, no particular limits have been set and but little is really known as to the productive capacity of the field. The oil from these wells is similar in every respect to that produced in the old field, except that it is heavier, the gravity ranging from 16 to 18° Baumé.

To the northeast of this field, along the apex of the field, several wells have been drilled which offered some encouragement, though none are now productive. On the whole, it is difficult to form an opinion as to the possibility of commercial production.

South of the Cat Canyon field several wells have found productive sands. Near the summit of the ridge, but on the south side, the Shaw Ranch company developed a small supply of oil of about 16° Baumé. Farther south, and lower down on the hills, the Syndicate has a small producer of about 18° Baumé. Farther east, and close to Los Alamos, the Pinal-Dome company has two producers of the heaviest crude oil, about 10°. All these scattering wells produce oil of the same chemical characteristics, differing merely in proportion of light and heavy products, the nature of this oil differing materially from that of any other found in the State.

On the whole, the Santa Maria field is in a healthy and prosperous condition. Like all others, it suffers from the low price ruling in the fuel market, but a constantly increasing proportion of the heavy oil is used in the manufacture of road oil and asphalt, the light oil all finds a market at a better than average figure, and the output of gas is put to the best use, the stripped gas being distributed to several nearby towns.

Determination of the fineness of cement by an air analyzer or elutriator is discussed by J. C. Pearson and W. H. Sligh in Technological Paper No. 48 of the Bureau of Standards. In the mechanical analysis of cement it is not feasible to use a sieve finer than 200 meshes to the inch. Most specifications require that at least 75% of the cement shall pass the 200-mesh sieve, but it has long been recognized that a large part of this fine material might still be too coarse to be acted upon by water and thus be practically inert material. For a finer separation, elutriation methods by which the desired separations are accomplished by washing or blowing, are necessary. Two types of apparatus are used, one employing a liquid and the other a gas. Gas or air-analyzers are believed to be the best for cement and the investigations of the authors were confined to this type. After a series of experiments with the kinds of apparatus at present in use, an analyzer was developed that gave reliable results which could be used as a basis for comparison with tests made with other analyzers. It was possible to separate the finer material into particles having an average diameter of 0.001 in., 0.002 in., and 0.003 in. respectively, and the determinations were accurate within 2%. While the investigation has so far been rather fragmentary, enough has been accomplished to show the importance of a more complete analysis than can be obtained by the use of sieves, especially in the study of the effects of fine grinding. The air-analyzer can also be used in studying the properties of other powdery materials than cement.

Purification by chlorination for the water-supply of Sacramento, California, has resulted in a marked reduction in the death-rate from typhoid fever. The water-supply of the city is obtained from the American and Sacramento rivers and there is a large population above the intakes, with a resulting danger of pollution. During 1914, there were 201 cases of typhoid and 16 deaths, for a population variously estimated at from 60,000 to 75,000. The chlorination process has been in effect since March 22 of this year. During April, May, and June there were seven cases of typhoid reported, as against 26 during the corresponding period in 1914. It is expected that the proportionate reduction will be still greater during the winter months, as in the past, cases of typhoid have been most prevalent during that period.

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Method of Prevention of Sand-Infiltration in Wells Supplying Panama-Pacific Exposition

The development of a water-supply for the Exposition is one of the topics discussed in a paper on 'Engineering Features of the Panama-Pacific Exposition,' by Guy L. Bayley, chief mechanical and electrical engineer, presented at the meeting of the American Society of Mechanical Engineers at San Francisco, September 1915. Considerable water was obtained from the Presidio system and a little from the city mains of the Spring Valley Water Co., but most of the supply was obtained from shallow wells drilled near Golden Gate park. The sandy soil in that part of the city absorbs the rainfall readily, which is prevented from seeping downward by an impervious clay stratum from 60 to 90 ft. from the surface. A test well was drilled 80 ft. deep and having an outside casing of 20-in. diam., and an inside casing 16-in. diam. Both casings were perforated with slots having $\frac{1}{16}$-in. openings, and the annular space between the casings filled with gravel ranging from rice to pea in size. This well produced 368,000 gallons per day and gave no trouble from sand.

Upon the completion of this well, four others were drilled nearby. Although these wells were drilled in the same way and were drilled in the same formation, they gave trouble because of 'sanding up' from the start. An air-ejector was used on the wells and would sometimes remove as much as 50 ft. of sand in a few hours. When the well was pumped again, the same trouble would be repeated. The removal of so great a quantity of sand from the wells caused a troublesome settlement at the surface.

It was decided that the failure of the wells was due to the size of the gravel which had been placed in the annular space between the outside and inside casings. Experiments were made to determine the proper mixture of sand and gravel, and also the proper perforations to allow the water to flow through freely. Flat test-plates 8 by 12 in. were prepared, each having a different size of perforation. These were tested by placing them in a wooden-frame box with trial mixtures of sand and gravel between the plates. Above the plates a quantity of sand was placed that had been taken out of the wells, and water was applied under pressure. The flow of water was measured by meter and the pressures taken for different rates of flow. The result of these experiments was the selection of naturally-graded uniform beach-sand that had an effective size of 0.42 mm. and a uniformity coefficient of 2.18. It was determined that with the use of this sand, plates could be used having a width of perforation of 1/32 in., and that the fine material from the wells would be held back even when the velocity through the perforations was as high as 0.75 ft. per second. As the maximum velocity through the perforations under operating conditions would never exceed 0.5 ft. per second, it was considered safe to use this material.

An additional well was drilled by Exposition forces by the use of an hydraulic ejector or sand-pump. The bottom section was made of a 5-ft. length of inner and outer casing, the inner casing being tapered to the diameter of the outer at the bottom and both riveted to a forged steel shoe. A hole was dug 5 ft. deep, at which point water was encountered, and the bottom section set in place. The sand-pump was placed inside and excavated the material down to the shoe. The first 15 ft. of casing went down of its own weight, but the rest of the way it had to be forced down by means of a long lever. The maximum force applied was about five tons and the average rate of progress of the casing was 1 in. per minute.

The well was completed to a depth of 60 ft. in five days. At one time the well got badly out of line, but was straightened by putting a jet down on one side and keeping a strain on the top of the casing with a block and tackle. After this, guides were put on the ejector-suction to keep it in a central position and no further trouble was experienced from this source. The outer casing for this well was 22-in. diam. of No. 12 gauge steel with collar joints, each section being 30 in. long, with perforations $\frac{1}{16}$ in. wide by $1\frac{3}{4}$ in. long. The inner casing had a diameter of 16 in. and had perforations 1/32 in. wide. Perforated casing was used except for the bottom section and the upper five joints. The material used between the inner and outer casings was determined as described above.

This well produced 200 gal. per minute without discharging sand, and it was decided to reconstruct the old wells that had been giving trouble from sand. It was impossible to remove the inner casing, but the diameter of the pumps used was such as to permit the placing of a string of $13\frac{1}{2}$-in. casing inside the well. The space between the $13\frac{1}{2}$ and the 16-in. casing was filled with material determined by the experiments already described. The wells as remodeled developed a satisfactory flow of water with no trouble from sand.

Protective paints upon metal that is to be embedded in concrete structures, in order to prevent any damage that might be caused by electrolysis, has been proposed. No tests have been made that have determined what type of coating is best suited for the purpose. It would appear from first consideration that a paint capable of forming a film of high electrical resistance would be most efficient. Such films, however, generally present a high gloss surface and are apt to prevent the proper bonding of the concrete with the painted metal, thus doing more harm than good. It is chiefly for this reason that paint is not used on reinforcing metal.

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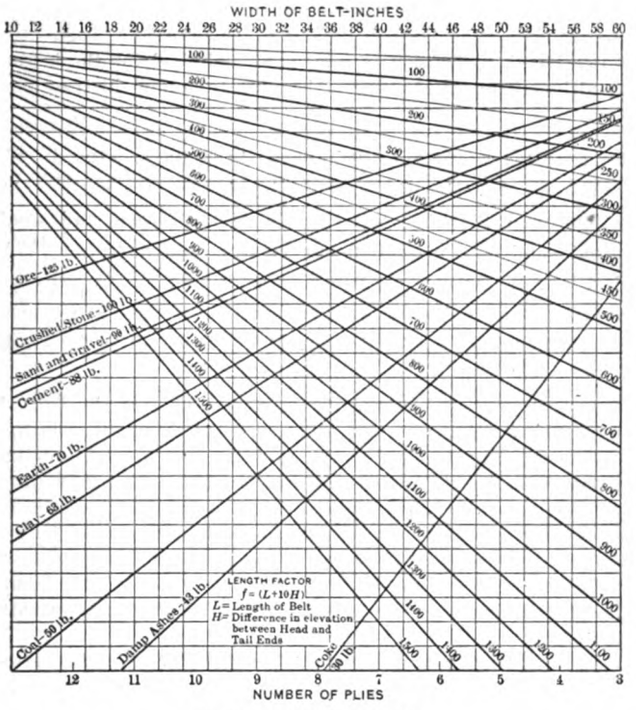
Engineers' Note Book

CONVEYOR-BELT CALCULATING CHART

By J. D. Mooney and D. L. Darnell

The accompanying chart is taken from a paper presented before the American Institute of Mining Engineers at its meeting in San Francisco, September 1915. The calculations are based on a factor of safety of 15 for the various standard rubber conveyor-belts. The calculations assume maximum loading-conditions; that is, the belt is considered as carrying the greatest load that it will handle without spillage at ordinary belt speeds. This not only produces the most economical operating conditions, but also the maximum tension on the belt.


WIDTH OF BELT-INCHES
10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
Ore-125 lb.
Crushed Stone-100 lb.
Sand and Gravel-90 lb.
Cement-88 lb.
Earth-70 lb.
Clay-63 lb.
Coal-50 lb.
Dump Ashes-45 lb.
Coke-30 lb.
LENGTH FACTOR
f = (L+10H)
L = Length of Belt
H = Difference in elevation between Head and Tail Ends
12 11 10 9 8 7 6 5 4 3
NUMBER OF PLIES

CONVEYOR-BELT CHART.

The chart is a graphical representation of the formula:

$$p = kgW(L + 10H)$$

Where, p = the correct number of plies.
k = a constant, depending on the type of drive
g = the weight in lb. per cu. ft. of material handled
W = the width of the belt in inches
L = the length of the belt in feet
H = the difference in elevation between the head and tail pulleys, in feet

For a simple drive, with a bare pulley, $k = \frac{1}{250,000}$

For a simple drive, with a rubber-lagged pulley, $k = \frac{1}{300,000}$

For a tandem drive, with bare pulleys, $k = \frac{1}{375,000}$

For a tandem drive, with rubber-lagged pulleys, $k = \frac{1}{455,000}$

The chart is drawn for a simple drive, with a bare pulley $k = \frac{1}{250,000}$;

therefore, the number of plies obtained from the chart should be multiplied by the factor 0.83 or $\frac{5}{6}$ for simple lagged drive; the factor 0.67 or $\frac{2}{3}$ for tandem, bare; and the factor 0.55 or 11/20, for tandem, lagged.

To find the correct number of plies for a conveyor-belt, knowing the width, the length, the difference in elevation between the head and tail ends, and the kind of material to be handled: Start from the width given at the top of the chart and move down until this line intersects the line corresponding to the proper length-factor; then move either right or left until the line corresponding to the given material is met; then move down again to the scale of plies, where the next largest figure will give the correct number of plies. For example: to find the correct number of plies for a conveyor-belt 36 in. wide and 300 ft. long, with 20 ft. difference in elevation; handling sand and gravel, follow the line from the 36-in. width downward until it intersects the 500 length-factor line; then follow to the right until the sand and gravel line is intersected; then down to the ply scale, where the ply will be found to be 7.

Hints on Practice

THE HOLDING POWER OF NAILS

The subject of the holding power of nails seems to have had the minimum of study as stated in the *Indian Textile Journal*, from which the following notes are taken. It is hard to discover the reasons that determine the size of nails or screws among woodworkers. A glance at the interior of any coasting boat will show that although every nail is clinched, a length of three inches is allowed for that purpose, while the spread of the head barely amounts to one inch. The waste of iron in nails alone cannot be less than from 20 to 25%. Hard woods are more common in tropical than in temperate countries, and as they are frequently joined with nails, some system should be adopted to obtain the best results.

A nail holds itself in place in two ways: by friction of its sides against the wood, and when clinched, by the resistance of the clinch which resembles a second but smaller head. The combined resistance of sides and clinch represent the total holding power of the nail. Square nails are usually tapered on two sides and parallel on the other two; the tapered sides should bear against the end grain of the wood, crushing it gradually as the nail enters; and when it is fully driven it bears uniformly against this end grain crushing it without splitting. All woods when soaked in water or when green may be nailed with less risk of splitting than when they are dry, but there are limits to the depth that a long nail may be driven into any wood before it begins to bend, that is to say, where the friction of the wood overcomes the driving power of the hammer. When a nail begins to bend it shows that a hole must be made beforehand; and the size of the hole is a matter of some importance. Its object is to reduce the friction so as to allow the nail to be driven without bending, but if made too large, the holding power of the nail will be reduced and clinching will be an imperfect remedy. If many nails of one size have to be driven, as in boat building, it is advisable to experiment on a piece of wood of the necessary thickness in order to find out the right size of hole that will avoid splitting the wood, or bending the nail. When large wire-nails are used in drilled holes, the size of the hole should be such as will ensure a good fit. If the nail is to be clinched it should be softened at the point by heating to redness. The wire nail is hard-drawn to enable it to be driven without bending in soft woods, but it does not clinch well for this reason, and therefore needs softening.

Nails that have rusted after being driven have an increased holding-power, but if rusted before use they tend to make a slightly larger hole than a smooth nail, because of their rougher surface. In cases where clinching would be likely to split the wood, nails may be cut and riveted over a small washer. This makes a strong and durable joint. There is also a way of clinching a nail within the wood that is at times

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useful. The point is filed away on one side to a wedge shape and then bent over the filed part until the point is level with the side of the nail. A hole is drilled to the size of the nail which is inserted with the filed surface parallel with the grain of the wood. When driven, the point takes the form of a hook and has a strong hold upon the wood. The point of this nail should be heated and softened so as to facilitate the turning of the point.

Screws offer an even more interesting subject for experiment, for it will be often found that if the hole for a screw is carelessly drilled it has less holding power than a nail. The holes for screws in hard wood should be carefully made in two sizes; for the neck and the screw, respectively; and the point of the screw-driver should be of the shape of the notch in the screw and not a chisel point as is usually seen. Failure to observe these rules may result in splitting or otherwise damaging the wood.

Book Reviews

PURCHASING. (Its economic aspects and proper methods). By H. B. Twyford. P. 236. Charts, 112 plates, index. D. Van Nostrand Co., New York, 1915. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

An excellent text book and guide for the instruction of purchasing agents and those whose partial duties include the placing of either large or small orders. Considerable time and money would be saved by both buyer and seller if the principles as outlined by the author were carefully followed by our present day purchasing agents. The splendid example of system as outlined in this book is in itself well worth the consideration of many who are only indirectly connected with actual buying.

EXAMPLES IN ALTERNATING-CURRENTS. Vol. I. For students and engineers. By F. E. Austin. P. 223. Ill., index. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.40.

This work has been carefully prepared, and is published in pocket size. It contains examples dealing with wave-length, frequency, sine and nonsine alternating-currents and pressures, generators, power, power-factor, capacity, inductance, and resonance, showing the process of solution, step by step, together with the fundamental equations applying, and the necessary data properly arranged. The diagrams are very clear, greatly assisting in an understanding of the fundamental principles. Electrical engineers will find the trigonometric formulæ of value, and tables of variable quantities for frequencies from 1 to 150,000 cycles.

MECHANICAL DRAWING. By James D. Phillips and Herbert D. Orth. P. 278. Ill., index. Scott, Foresman & Co., Chicago and New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.75.

This work is primarily a class-room textbook. Directions for the drawing of 'plates' are given with the text and an outline for a course in mechanical drawing is given at the end of the book. The first chapter is devoted to a brief treatment of 45-degree perspective drawing, so brief that the average student would have great difficulty in comprehending the subject without the guidance of a skilful instructor. The general principles of orthographic sketching are then discussed. The mechanical details of drafting are then considered, beginning with pencil-work, and then tracing and blueprinting. Instruments and materials of drawing are then discussed, and then the various signs and other conventions in common use. A chapter is devoted to lettering and one to 'Advanced Drawing,' the latter dealing with the preparation of complete working drawings of several rather complicated machine parts. Some space is also devoted to isometric drawing, and the last chapter gives some suggestions to instructors using the volume as a text book. The book is well illustrated and will be found to be of value both in the class-room and the drafting-office.

DIRECTIONS FOR DESIGNING, MAKING, AND OPERATING HIGH-PRESSURE TRANSFORMERS. By F. E. Austin. P. 46. Illustrated. For sale by *Mining and Scientific Press*, San Francisco. Price, 65 cents.

The author of this work is head of the department of electrical engineering at the Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire, also the author of three books on kindred subjects. In these days of the generation and transmission of high-voltage alternating current some means of reducing the pressure to one suitable for driving motors is of importance, hence the many designs of transformers. The theory, details of construction, cost, etc., are explained. The book is somewhat technical for the beginner, although amateurs should be able to follow instructions given.

UNITED STATES MINING STATUTES ANNOTATED. By J. W. Thompson. Bulletin 94. Law Serial 4. In two parts: (1) 'Sections and Statutes Relating to Metalliferous and Coal Mining'; and (2) 'Miscellaneous Mining Subjects.' P. 1772. Index. U. S. Bureau of Mines, Washington, D. C. Orders should be sent to the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, $2.50 for cloth binding. Not sold separately.

This bulletin is a compilation of all sections of the United States Revised Statutes and of all acts of Congress relating to mines, mining, mineral lands, and the mining industry on the public lands. It is intended for persons engaged in mining enterprises that come within the scope of Federal mining laws and as a guide as to the determination of mining rights and duties. It shows the status of every Federal mining law, both laws relating to metal mining and those relating to coal, oil, and phosphate, and to mining on public, Indian, and railroad lands.

The bulletin relates only to the United States mining laws and does not include any of the laws of the different states in regard to mining. Another bulletin which the Bureau hopes to print in the future will contain the state laws.

In addition to the Revised Statutes and the acts relating to metal, coal, and oil and gas, acts relating to the following subjects, as they bear upon the mining industry are included: Alaska, Indian Lands, Lead Mines, Philippine Islands, Pipe Lands, Railroad Grants, Rights-of-Way, Salines and Salt Springs, Settler's Relief Acts, State and Public Grants, Stone Lands, Timber Cutting for Mining Purposes, Town Sites, Tunnel Acts, and Withdrawals.

All sections and acts are annotated. These consist of abstracts of decisions of all courts and public officers wherein any of these sections or statutes are explained, construed, and applied. The annotations are arranged under each section or statute with appropriate title lines in definite order, and consist of plain propositions of law, and point out how the courts have cured many defects, made clear the uncertainties, and aided in the practical application of these statutes. The large number and wide range of these decisions show that the practical value of the mining laws depends on their present status as established by the courts.

The preparation of these annotations involved an examination of more than 2000 volumes of reports of various courts and public officers. The work is indexed and any desired subject may be readily found. The work on this bulletin has been so expensive that it has been necessary to place the above price on it.

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How to Make Low-Pressure Transformers. Second Edition. By F. E. Austin, Hanover, New Hampshire. For sale by the *Mining and Scientific Press*, San Francisco. Price, 40 cents.

This little book is a companion to the author's work on the design, etc., of high-pressure transformers, and from it amateurs and others will be able to construct their own apparatus. Transformers appear to be complicated to the layman, and here is everything easily explained.

General Specifications for Concrete Work as Applied to Building Construction. By Wilbur J. Watson. McGraw-Hill Book Co., Inc., New York. P. 56. Illustrated. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.

This is the second edition of this valuable work, the first appearing in 1908. The progress in concrete design, both plain and reinforced, has been sufficient since that time to warrant a new edition. The scope of the book includes rules and formulæ for computing and designing and also regulations governing the actual construction, using both plain and reinforced concrete. Several useful tables are included. The book will be valuable to anyone having to do with concrete buildings and in less degree, concrete construction of any kind. Its usefulness might perhaps be increased by the addition of an index to supplement the table of contents.

The Elasticity and Resistance of the Materials of Engineering. By William H. Burr. P. 919. Ill., index. John Wiley & Sons, Inc., New York. For sale by the *Mining and Scientific Press*, San Francisco. Price, $5.50.

This is the seventh edition of this valuable treatise, which appeared first in 1883. Much new material has been added since the last edition and a large part of the book has been re-written. In particular, the section on reinforced concrete is almost entirely new, the design of columns and beams of this material being taken up in considerable detail. The first two chapters of the book are devoted to the general theory of elasticity and of flexure, including a discussion of shearing stresses. Torsion is then considered and the resistance of various materials when subjected to this form of stress is given. The next chapter considers the strength of hollow cylinders and spheres. Then come discussions of resilience and of combined stresses. The second part of the book takes up the properties of the various materials of engineering with reference to both tension and compression. Riveted joints and pin-connections are next considered. The treatment of long columns of various materials is thorough. Beams and plate-girders are next considered. Stressses in various miscellaneous articles such as hooks, springs, rollers, spikes, etc., are then discussed. Two chapters are devoted to the fatigue of metals and to the flow of solid bodies under stress. The principal appendix contains a theoretical discussion of elasticity.

Industrial Progress

PROTECTION OF SINGLE ALTERNATING-CURRENT TIE-LINES

Single-pole, double-throw relays of the type illustrated have recently been developed by the General Electric Co. These relays provide a simple and effective means of isolating trouble automatically on a single-tie line joining parts of an alternating-current system. Two relays connected together by pilot wires are required on each end of a three-phase tie. Under normal conditions, irrespective of the direction of the power, which may reverse at any time over the entire tie line, depending on the distribution of the load and the characteristics of the system, the relays have no effect on the oil-switches. If, however, a short circuit occurs in the tie-line while power is being fed from one part of the system to the other, this power will go directly into the short circuit, while

TOP VIEW OF RELAY.

the power in the tie between the short circuit and the part of the system previously receiving power will reverse and also feed into the short. This will operate the contacts of the relay in the reversed portion of the line, which will cause the oil-switches on both ends of the line to trip and isolate the line from the rest of the system.

The relays will not operate on overload, or on trouble on other lines unless accompanied by a reversal of power only on one end of the line that they are meant to protect. They will, however, operate on little reverse power, even at low voltage and low power-factor, and are consequently of great value for the service recommended.

THE LAWSON LOOP-LINE TRAMWAY

Many transportation problems are best solved by the use of an overhead tramway. For this purpose, the Ambursen Co., of New York City, represented on the Pacific Coast by Edward R. Bacon Co., has devised the Lawson Loop-Line Tramway.

THE LAWSON TRAMWAY.

The cars are smooth pressed steel, the bodies being made of one piece, and riding on four grooved wheels each on its own axle. Each car is an independent conveyor. The capacity of the tramway can be varied by simply increasing or decreasing the number of cars. Ordinary wire rope is used for the track. The loaded cars run on the upper track and return empty on the lower track. One man can load the cars and they dump automatically on reaching the terminal. The cars in dumping are self-cleaning. The track is made in small units and can be arranged for any grade or curve.

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Construction News Summary

SUMMARY OF BIDS FOR CONSTRUCTION OF HETCH-HETCHY RAILROAD

The following bids were received by the Board of Public Works of the city of San Francisco for the construction of the railroad from Rosasco on the Sierra railway to the dam-site in the Hetch-Hetchy valley. The totals were as follows:

No. 1.	F. Rolandi, San Francisco	$1,543,080
No. 2.	Mason & Hangar Co. (representing Mac-Arthur Bros.), San Francisco	1,555,376
No. 3.	Utah Construction Co	1,800,925
No. 4.	Porter Bros.	1,810,807
No. 5.	Tibbitts Pacific Co	1,955,063
No. 6.	Twohy Bros. Co	1,911,065

Item and unit.	Quantity.	1.	2.	3.	4.	5.	6.
Excavation, cu. yd.							
Granite	161,673	$1.05	$1.17	$1.23	$1.30	....	$1.36
Solid rock	376,540	0.94	1.07	0.80	1.20	....	1.36
Soft rock	97,801	0.70	0.69	0.45	0.70	....	0.75
Earth	372,735	0.37	0.38	0.30	0.33	....	0.36
All material	1,008,749	0.67	0.794	0.62	0.93	0.83	1.04
Culverts, lin. ft.							
12-in. iron	811	0.98	1.25	1.20	1.505	1.50	1.30
12-in. steel	811	0.90	1.25	1.15	1.445	1.45	1.23
24-in. iron	4,454	1.90	2.25	1.80	2.78	2.55	2.30
24-in. steel	4,454	1.75	2.25	1.70	2.66	2.40	2.20
30-in. iron	527	2.70	3.00	2.80	3.765	3.50	3.20
30-in. steel	527	2.50	3.00	2.65	3.585	3.30	3.10
36-in. iron	944	3.30	3.75	3.25	4.615	4.20	3.80
36-in. steel	944	3.15	3.75	3.10	4.395	3.90	3.70
Common fencing, mile	30	600.00	425.00	475.00	500.00	812.00	420.00
Hog-tight fence, mile	10	670.00	425.00	570.00	625.00	750.00	500.00
Broken stone ballast, mile	9.4	2122.80	2700.00	2535.00	3000.00	3360.00	2000.00
Gravel ballast, mile	9.4	1592.10	2250.00	1335.00	2250.00	1690.00	2400.00
Selected ballast, mile	9.4	707.60	1350.00	1235.00	1720.00	1045.00	1900.00
Broken stone ballast, mile	15.7	1592.10	2700.00	2535.00	3000.00	3040.00	2000.00
Gravel ballast, mile	15.7	707.60	2250.00	1370.00	2250.00	1525.00	2300.00
Selected ballast, mile	15.7	1061.40	1350.00	1135.00	1720.00	895.00	1900.00
Broken stone ballast, mile	17.2	1592.10	2700.00	2535.00	3000.00	2540.00	2000.00
Gravel ballast, mile	17.2	1326.75	2250.00	1285.00	2250.00	1400.00	2000.00
Selected ballast, mile	17.2	1061.40	1350.00	1085.00	1720.00	895.00	2000.00
Broken stone ballast, mile	13.7	1592.10	2700.00	2535.00	3000.00	2760.00	2000.00
Gravel ballast, mile	13.7	1405.20	2250.00	1285.00	2250.00	1580.00	2300.00
Selected ballast, mile	13.7	1061.40	1350.00	1085.00	1720.00	875.00	2000.00
Broken stone ballast, mile	13.0	2034.25	2700.00	2535.00	3000.00	2540.00	2000.00
Gravel ballast, mile	13.0	1503.65	2250.00	1285.00	2250.00	1350.00	2000.00
Selected ballast, mile	13.0	884.50	1350.00	1085.00	1720.00	975.00	2000.00
Track construction, mile	69.0	8450.00	9750.00	9485.00	8726.88	11,480.00	9100.00
Switches, frogs, etc., each	30	140.00	175.00	190.00	224.24	200.00	225.00
Guard rails, foot	20,000	0.62	1.00	0.50	0.50	0.11	0.60
Iron castings, lb	2,400	0.065	0.07	0.09	0.0375	0.08	0.06
Rail braces, each	25,000	0.33	0.30	0.32	0.27	0.44	0.21
Anti-creepers, each	10,000	0.21	0.25	0.27	0.22	0.27	0.21
Derails, each	10	15.00	30.00	14.00	10.00	32.00	20.00
Cattle-guards, each	100	15.00	25.00	14.00	29.90	25.00	20.00
Redwood tanks, each	8	400.00	550.00	365.00	377.05	670.00	420.00
Steel tanks, lb	60,000	0.04	0.08	0.08	0.072	0.086	0.06
Equipment for oil tank	1	995.00	850.00	550.00	785.68	1200.00	1800.00
Equipment for oil tank	2	1282.00	1700.00	560.00	1432.42	2200.00	2300.00
Steel truss-bridge, lb	470,000	0.055	0.052	0.06	0.0596	0.069	0.0625
Steel plate-girder approach, lb	130,000	0.053	0.052	0.055	0.0578	0.06	0.0575
Lumber, M.B.M.	450	40.00	40.00	43.00	40.00	63.00	70.00
Iron (trestles), lb.	25,000	0.05	0.06	0.05	0.04	0.063	0.06
Concrete masonry, cu. yd	2,500	12.00	14.00	8.50	12.00	14.50	11.00
Rubble masonry, cu. yd	1,000	3.00	3.50	3.50	5.00	4.00	8.00
Dry rubble, cu. yd	2,000	2.00	2.50	2.50	2.00	2.00	6.00
Rip-Rap, cu. yd	1,000	1.75	1.50	0.65	1.00	1.00	6.00
Telephone line, mile	50	575.00	700.00	415.00	500.00	540.00	340.00
Telephone line, mile	9	380.00	250.00	245.00	114.33	112.00	100.00
Telephone sets, each	10	16.00	25.00	25.00	16.17	50.00	20.00

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PRESENT STATUS OF ENGINEERING PROJECTS ON THE PACIFIC COAST

(Engineers and others connected with construction work are invited to make use of these columns to acquaint other members of the profession and the general public with the progress of work under their charge.)

GENERAL CONSTRUCTION IN CALIFORNIA

Two government suction-dredges, working on the channel of the Sacramento river near Collinsville, removed 244,080 cu. yd. of material during the month of October. One of these dredges, however, was used during the latter half of the month in the excavation of cut-off 'B,' on the San Joaquin river, removing about 198,500 cu. yd. of material. Cut-off 'C' on San Joaquin river was completed during the month by a suction-dredge hired for the purpose, 40,000 cu. yd. of material having been moved. This work was begun in October 1914, but was discontinued in February 1915 on account of weather conditions at that time.

The $130,000 reinforced concrete bridge on the State highway over the Yuba river at Marysville has been completed. During the month of October, 16,000 sq. yd. of concrete lining has been laid on the laterals of the irrigation system of the Orland project. The force has been increased to 20 men and it is expected that 19,000 sq. yd. will have been laid during November. Since the beginning of the work, 153,000 cu. yd. of lining has been placed. In Richmond, paving of Cutting boulevard has been completed. In Stockton, work is now under way on nine street-improvement contracts, the total cost of the work being $225,000; four sanitary-sewer contracts, total cost $54,000; two storm-sewer contracts, total cost, $40,000; and one contract for the construction of a concrete bulkhead along part of waterfront, costing $4600. Work on the sewer and water system for the naval radio station near San Diego has been finished and progress has been made on the erection of buildings and of the three 600-ft. steel towers.

In Hetch-Hetchy valley, preparatory work for the construction of the diversion dam is under way. Camp buildings have been erected, all but 200 ft. of the diversion tunnel has been driven. Clearing of dam-site is under way. In Los Banos twenty blocks of permanent street-pavement, the first in the city, has been finished. State Highway Commission has accepted the following highways: through town of Davis, 1.15 miles; from Sutter county line to Gridley, 4.12 miles; from Keystone to Sonora, 11.4 miles; along San Pablo avenue, Alameda county, 0.50 mile.

GENERAL CONSTRUCTION IN OREGON

South Fork water-system, supplying Oregon City, has been completed at a cost of $350,000. The water-system for the town of West Linn, which is also to be supplied from the South Fork pipe-line, is practically completed. The cut-off on the Oregon-Washington Railroad & Navigation Co. line between Echo and Coyote is finished and will soon be turned over to the operating department. In Portland, the Montavilla trunk-sewer system will be completed about December 10. On the railroad being built west from Riverside, Malheur county, rails are laid as far as Crane creek. This road is to continue west and connect with the Southern Pacific at Natron. On the Columbia River the Interstate bridge between Portland and Vancouver, Washington, all but one of the piers in Oregon and Columbia sloughs have been placed. Seven piers in the river itself have been completed and two abutments. The large embankments on Hayden island, between Columbia and Oregon sloughs, and between Oregon slough and the mainland are nearly finished. Four steel spans, each 265 ft. long, have been assembled by the contractors, McCreary & Willard, who are now preparing to float them into place. There will be 13 of these spans in the entire bridge.

GENERAL CONSTRUCTION IN WASHINGTON

State highway work for the season is drawing to a close, although there are some contracts situated so that work can be continued through the winter. Up to November 1, contracts for approximately $900,000 worth of work have been awarded, and it is estimated that the total expenditure for highway-construction for the year will be $1,200,000. This will leave $720,000 of the legislative appropriation available for work during 1916. During 1915, $248,000 has been spent on various portions of the Pacific highway, $159,000 on the Olympic highway, $152,000 on the Sunset highway, $112,000 on the National Park highway, and $13,000 on the McClellan Pass highway. On secondary highways, $173,000 has been expended, including $52,000 on the Spokane-Newport road, and $23,000 on the road along the Columbia river in Skamania county.

In Port Townsend, Water street has been opened and extended about 1800 ft., involving the cutting down of a high bluff next to the water. The total excavation was 110,000 cu. yd., the total embankment, 10,000 cu. yd., and the total cost was $15,855.08.

General Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALAMEDA—Bids will be received until December 7 by R. E. Bosshard, city clerk, for furnishing one automobile chassis for converting horse-drawn hose-wagon into motor-driven combination chemical and hose-wagon, one motor-driven lawn-mower, and one automobile truck.——Improvement of Central avenue for 1½ miles has been proposed.

ALPAUGH—Board of Trustees of Alpaugh irrigation district has approved plans for concrete-lined distribution system.

ARBUCKLE—Chamber of Commerce has voted to purchase street sweeper. D. S. Nelson is interested.

ARCADIA—Contract for construction of 16½ miles of 6-in. oil macadam roads and 10,000 lin. ft. concrete curbs has been awarded to Rogers Bros. Co., 505 Hibernian Bank Bdg., Los Angeles, for $110,000.

AUBURN—Bonds for $22,000, $15,000 for sewer extensions and septic tank, $5000 for purchase of automobile fire-trucks, and $2000 for fire-alarm system have been voted.——North Fork Ditch Co. is raising dam.

AZUSA—Nevada Powder Co. will build powder-plant. Estimated cost is $19,000.

BAKERSFIELD—Contract for grading and construction of culverts on section No. 2 of Caliente-Kernville road has been awarded to Castro-Blaisdell Co. for $12,158.95.——Contract for paving six miles of Weed Patch loop has been awarded to Worswick Street Paving Co., Modesto, at the following unit prices: excavation, 40c.; shaping roadbed, 6c.; concrete paving, 60c.; a total of $31,460.40.——Contract for construction of asphaltic pavement on Brundage lane and on Bellevue road has been awarded to Clark & Henery Construction Co., Stockton. County furnishes cement. Total length of pavement, four miles.——Contract for construction of section No. 4 of road to Glennville has been awarded to Shattuck-Nimmo Warehouse Co.——Contract for construction of section No. 7 of road to Mojave has been awarded to Robert Sherer & Co., Pacific Electric Bdg., Los Angeles, for $13,464.54. Other bidders were:

Geo. S. Benson & Sons	$15,967.70
Castro & Blaisdell	16,465.98
Spring Construction Co.	18,690.40
L. G. Garnsey	19,434.26
Twohy Bros. Co.	22,507.75
R. Rothwell	24,322.35

Board of Supervisors has decided to proceed with construction of road from Weldon to Cannel Meadows, 12 miles. Estimated cost is $43,000, which is to be paid from general road fund.——Bids will be received until December 7 by I. L. Miller, county clerk, for construction of bridge over branch of Kern Island ditch on Brundage lane.——Bids will be received until December 9 by I. L. Miller, county clerk, for grading and construction of bridges on section 3 of Caliente-Kernville road, and for grading and construction of pavement and culverts on section 1-A of McKittrick road.——Election has been called for December 14 to vote on bond issue of $75,000 for construction of school buildings.

BERKELEY—Plans for several ornamental lighting districts have been considered. F. T. Robson is commissioner of public works.

BRAWLEY—Contract for improving several streets has been awarded to California-Arizona Construction Co., 1700 East Washington street, Los Angeles, at 25c. for grading and bitulithic pavement, 45c. for cement, and 28.8c. per sq. ft. for concrete gutters.

CALEXICO—Contract for erection of school No. 1 has been awarded to James P. Dawson, 718 Fay Bdg., Los Angeles, for $14,578. Contract for school No. 2 has been awarded to Welch & Wright Construction Co., El Centro, for $17,970.

CLOVERDALE—Contract for construction of concrete bridge on First street has been awarded to John B. Cooley.

COALINGA—Plans are being prepared for construction of irrigation canal from Warthan creek to Well's ranch, about five miles. C. A. Hively is interested.

CORONA—Contract for improvement of several streets has been awarded to Johnson-Shea Co., Riverside, at 8c. for macadam, 11c. for concrete pavement, a total of $6969.56.

COMPTON—Contract for construction of sewer system has been awarded to Jas. Kennedy, Washington Bdg., Los Angeles, for $42,407.60.

COLUSA—Plans are being prepared for formation of irrigation district containing 10,000 acres. Water will be pumped from Sacramento river. P. B. Arnold, W. F. Klewe, and John O'Sullivan are interested.

DAVIS—Southern Pacific railroad will construct subway under own tracks.

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DENAIR—Election has been called for December 9 to vote on formation of lighting-district.

EL CENTRO—Contract for construction of joint sanitary sewer system for El Centro and Imperial has been awarded to James Kennedy, Washington Bdg., Los Angeles, for $206,199.

ETNA—Contract for construction of sewers at grammar school has been awarded to Coffeen & Price, Medford, Oregon, for $940.

FAIRFIELD—Landowners between Rio Vista and Suisun are considering formation of irrigation district. D. E. Brownell and William Denman are interested.

FOLSOM—Supervisor Russi is building two miles of concrete road in this vicinity.

FRESNO—Contract for construction of hollow-tile residence for A. G. Wishon has been awarded to Trewhitt & Shields, for $15,380.——Contract for construction of concrete approach to Collins bridge near Sanger will probably be awarded to Benson & Johnson, Kingsburg, for $1200.

GOSHEN—Contract for construction of brick and concrete school has been awarded to Charles D. Sturtevant, for $8500.

HERMOSA BEACH—Contract for grading and construction of concrete pavement, cement curbs and sidewalks, and ornamental lighting posts on several streets has been awarded to California-Arizona Construction Co., 1700 East Washington street, Los Angeles, for $18,578.

JACKSON—Bond issue for $250,000 for construction of county highway system has been proposed. Lawrence Burke, Plymouth, is interested.

LAKEPORT—Election has been called for December 30 to vote on formation of Lake County water district. District will include entire southern part of county.

LINDSAY—Contract for paving five blocks on Hermosa avenue has been awarded to Worswick Street Paving Co., Fresno, for 10c. per sq. ft. for pavement, 5¾c. for construction of shoulders for pavement, and $2.50 per lin. ft. for culverts.——Lindsay-Strathmore irrigation district has been formed. District will contain 17,000 acres. Bond issue of $1,700,000 has been proposed and election will soon be called. McKee Moahn is treasurer.

LIVE OAK—Landowners of district No. 777 are considering plans for drainage system costing $50,000.

LOS ANGELES—Contract for improvement of Edgemont street has been awarded to George H. Oswald, O. T. Johnson Bdg., at the following unit prices: grading, 1c.; asphalt paving, 12c.; curbs, 30c.; sidewalks, 10c.; concrete gutter, 16c.; granite block gutter, 40c.; a total of $9138.60.——Contract for improvement of Enterprise street has been awarded to George R. Curtis, 552 South St. Louis street, at the following unit prices: grading, 1c.; asphalt pavement, 11.4c.; curbs, 30c.; granite-block gutter, 40c.; a total of $6692.34.——Contract for improving Pasadena avenue has been awarded to Ford & Stout, Bradbury Bdg., for $6238.51.——Contract for improving Minnesota street has been awarded to H. C. Withers, Builders Exchange, at the following unit prices: grading, 8½c.; cultivating, tamping, and oiling, 1½c.; curbs, 32c.; sidewalks, 11c.; concrete gutters, 15c.; a total of $220.43.——Contract for improving Ord street has been awarded to H. C. Withers, Builders Exchange, at 1c. for excavation, 11c. for asphalt pavement, and 30c. for curbs.——Contract for improving Western avenue has been awarded to George R. Curtis, 552 South St. Louis street, for $49,266.30.——Contract for improving several county roads has been awarded to Fred Hoffman, 111 East 12th street, Long Beach, for $6220.73.——Contract for improving part of Anaheim-Artesia road has been awarded to F. M. West, Fullerton, for $6859.80.——Contract for improving Bonita Terrace has been awarded to W. Liddington at 1c. for grading, 12c. for concrete pavement, 10½c. for asphaltic concrete pavement, 28c. for curbs, 13c. per sq. ft. for concrete gutters, and 40c. for granite-block gutters, a total of $3216.11.——Contract for improving Rampart street has been awarded to Bryant & Austin, 1650 Compton avenue, at 2c. for grading, 16.9c. for bitulithic paving, 30c. for curbs, 12c. for sidewalks, 16c. per sq. ft. for concrete gutters, a total of $4537.93.——Contract for construction of three miles of concrete pavement on Palmdale-Lancaster road has been awarded to H. E. Cox, Chamber of Commerce Bdg., Pasadena, for $24,351.40.——Ford & Stout, Bradbury Bdg., have been awarded a private contract for about $30,000 for laying 250,000 sq. ft. of asphalt pavement, with 4-in. concrete base, 1-in. binder-course, and 1½-in. sheet-asphalt wearing surface.——Contract for construction of the following bridges on State highway has been awarded to Mesmer & Rice, Marsh-Strong Bdg.: plate-girder bridge 247 ft. long over Castaic creek, at $30,761; plate-girder bridge 244 ft. long over Santa Clara river, at $25,974; plate-girder bridge 149 ft. long over San Francisquito creek, at $16,579; steel-truss span with plate girder approaches 270 ft. long over Santa Clara river, at $31,875.——Bond issue of $2,850,000 for construction of additions to county highway system has been defeated.——Board of Supervisors has appropriated $325,000 for construction of 20-ft. concrete highway, 30 miles long from Saugus via Mint Canyon to Palmdale.——Contract for construction of buildings for American Trona Corporation at San Pedro and at Searles Lake has been awarded to F. O. Engstrum Co., 5th and Seaton streets, for about $300,000. Structural steel will be furnished by the Llewellyn Iron Works, Main and Redondo streets.——Following bids have been received for construction of municipal warehouse at San Pedro. Merchants Realty & Investment Co., $117,138.75; F. O. Engstrum Co., $118,465; Somers-Lund Co., $120,607; Western Building & Engineering Co., San Francisco, $123,423.50; Foster-Vogt Co., San Francisco, $155,893.53; Alta Planing Mill Co., $162,222.50; Jacobs Construction Co., $164,860; C. J. Kubach Co., $183,524.——Pacific Electric Co. will construct reinforced concrete additions to elevated track at Main street terminal and other improvements costing $340,000. E. C. Johnson is assistant chief engineer.——Board of Public-Service Commissioners has awarded contract for furnishing 70 tons of pig-lead to H. R. Boynton & Co., 216 North Los Angeles street for $5.25 per 100 pounds.——Plans have been prepared for West Jefferson storm-drain. It will extend from Alameda street to Ballona creek, 7½ miles. Estimated cost is $1,100,000.——Bids will be received until 11 a.m., December 10, by R. R. Raymond, U. S. Engineer, 723 Central Bdg., for furnishing 25,250 tons crushed rock, 12,800 tons sand, and 19,000 bbl. cement.——City engineer Homer Hamlin has reported in favor of construction of new outfall sewer. Estimated cost is $2,000,000.——Councilman Topham has reported in favor of construction of union depot.

MADERA—Contract for construction of reinforced concrete bridge over Fresno river at D street has been awarded to Manning Bros., Fresno, for $9470.

MANHATTAN BEACH—Contract for improving several streets with 4 and 5-in. concrete pavement, sidewalks, curbs, and ornamental lighting posts has been awarded to Modern Construction Co., Wright & Callender Bdg., Los Angeles, for $39,629.60.——Contract for improving 30th street has been awarded to California-Arizona Construction Co., 1700 East Washington street, Los Angeles, for $4233.86.

MARICOPA—Bond issue of $15,000 for construction of high-school has been voted. A similar issue was voted a few months abo, but the bonds were declared invalid because of a technicality.

MARTINEZ—W. S. O'Brien will construct cement and asphalt plant costing $20,000.

MARYSVILLE—Contract for construction of concrete retaining walls for approach to Yuba River bridge has been awarded to Clinton Construction Co., San Francisco, for $2622.60.——Yuba Construction Co. will construct new dredge, No. 15, for Yuba Consolidated Goldfields Company.

McKITTRICK—General Petroleum Co. will build 6-in. pipeline from Lost Hills to Bear Creek property, about 30 miles.

MERCED—Plans and specifications have been adopted for a bridge in road district No. 4 and one in road district No. 5. County surveyor A. E. Cowell has been ordered to prepare plans for bridge over canal on Cottonwood-Newman road, and one over Quinto creek.——Contract for construction of reinforced concrete bridge over Santa Rita slough has been awarded to Angle & Bibler, Dos Palos, for $4725.

MILPITAS—Bonds for $12,000 for erection of school building have been voted.

MODESTO—Following bids for work have been received by Modesto irrigation district: construction of section between Dry Creek flume and canal:

George A. Bos, San Francisco	$2,251.00
Tieslau Bros.	2,572.00

For construction of nine concrete drops in lateral No. 3:

George J. Ulrich	$19,340.75
M. Blumenkranz	20,467.30
Thurston & Co	20,956.95
Contra Costa Constr. Co	21,232.00
W. B. Esterly	21,332.50
Tieslau Bros.	21,583.50
George A. Bos	22,255.50
V. M. Price	22,298.80
Barrett & Hilp	24,469.70
Macrae Loyaz	24,942.29

Following bids have been received for construction of dam No. 1 of Dallas reservoir for Modesto irrigation district:

Peart Bros., Oakdale	$72,800
Contra Costa Const. Co., Berkeley	75,000
Tibbetts-Pacific Co., S. F.	77,770
Ross Construction Co., Sacramento	78,050
Teichert & Ambrose, Sacramento	80,540

Contract for construction of dam No. 1 for Dallas reservoir has been awarded to Peart Bros., Oakdale, for $72,800.——Board of Directors of Modesto irrigation district have awarded contract for extension of Curtis drain to W. W. Higgins for 7c. per cu. yd.——Contract for furnishing gravel to Modesto irrigation district for dam No. 1 has been awarded to John Roen for 15c. per cu. yd.——Contract for paving several streets

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has been awarded to Worswick Street Paving Company.——County surveyor E. H. Annear is preparing plans for improvement of one mile of road just north of Newman.——Supervisors will appoint commission to prepare plans for county highway system. Estimated cost is $1,500,000. T. H. Kewin is interested.——Bids will be received until December 14 by Board of Supervisors for construction of bridge across Dry creek near Paulsell and reinforced concrete bridge over lateral No. 5 near town.

MORGAN HILL—Contract for improvement of Monterey street with oiled macadam pavement has been awarded to McCasley & Hamilton, San Jose, for $6249.

NEWCASTLE—Bonds for $12,000 for school purposes have been voted. Concrete building will be erected.

OAKDALE—South San Joaquin irrigation district will construct reservoir. There will be an earth dam with concrete outlet. Estimated cost is $20,000.——Contract for construction of concrete lining for canal and tunnel for South San Joaquin irrigation district has been awarded to Edward O'Malley, 821 Fillmore street, San Francisco. Work is to be done on a cost plus 10% basis, with the guarantee that the work in the tunnel shall not cost more than $12 per cu. yd. and the work in the canal not more than $8.

ONTARIO—Bids will be received until 7:30 p.m., December 6, by city clerk, for construction of 252,000 sq. ft. of 4-in. concrete pavement with asphaltic oil wearing surface ⅜ in. thick on A street and on Bon View avenue, and 259,000 sq. ft. of similar pavement on Euclid avenue. Estimated cost of first work is $25,460, and of Euclid avenue is $26,877.——Construction of pavement on East State street, and of pavement, concrete culverts, and concrete curbs on San Antonio avenue is proposed. The State street work will be done in January, and the other in April. Total pavement, 565,000 sq. ft. and 36,960 lin. ft. of curb. B. B. Mann is city engineer.

OROVILLE—Contract for grading on Western Canal has been awarded to Arthur Crum, Oroville.——Contract for construction of part of second section of Western canal has been awarded to Daniels Bayles, Biggs. Work will soon be started on third unit. Great Western Power Co., 14 Sansome street, San Francisco, is interested.——Irrigation district near Thermalito, containing between 5000 and 7000 acres, is proposed. Water is to be taken from West branch of Feather river. Oscar Warner is interested.——United States Exploration Co. will start extensive mining operations in Granite Basin. Roads will be constructed and mill capable of handling 100 tons of ore installed. O. W. Posey is interested.

PARADISE—Petition for creation of water district will be presented to supervisors at their December meeting. County surveyor M. C. Polk has reported that the cost of system, using either Little Butte Creek dam-site or Doon site, will be about $116,500.

PASADENA—Cities of Pasadena, South Pasadena, and Alhambra have purchased 600 acres of land for sewage farm. This is the first step in the construction of a joint sewage-disposal system for the three cities. R. V. Orbison is city engineer of Pasadena.——Contract for construction of concrete storm-drains has been awarded to Mlagenovich & Gillespie, Los Angeles, for $25,299.35.

PATTERSON—Surveys are being made for Patterson & Western railroad, from Patterson to magnesite mines, a distance of 22 miles. C. S. Compton, Paradise, Butte county, is chief engineer. Road will be narrow gauge.——Contract for construction of cement lining for five miles of canal for Patterson Water Co. has been awarded to Concrete Pipe & Irrigation Co., Portersville.

POMONA—Election has been called for January 11 to vote on bond issue of $50,000 for street improvements, storm-water protection, and construction of Chamber of Commerce building.

RICHMOND—City trustees have engaged J. H. Dockweiler, Grand Bdg., San Francisco, as engineer to report on water-supply question.——Contract for construction of improvements in Canal subdivision, including sewers, pavement, and a sump has been awarded to Richmond Dredging Co. for $92,952.80.

RIVERSIDE—Contract for construction of reinforced concrete bridge over Santa Ana river on Hamner avenue has been awarded to Hugh G. Purcell, Los Angeles, for $11,357.——Conner Contracting Co., 709 Higgins Bdg., Los Angeles, was low bidder and was awarded contract for construction of 8.96 miles of route No. 8 at the following unit prices: excavation, 23c.; class A concrete, $10; class B concrete in pavement, $4; class B concrete in structures, $10; class C concrete, $10; reinforcing steel, 4c.; guard fence, 40c.; a total of $61,825.——B. R. Davisson Contracting Co., Monrovia, was low bidder and was awarded contract for grading and construction of 11 miles of 9-ft. concrete pavement on part of route No. 18 at the following unit prices: excavation, 65c.; shaping, 8c.; class A concrete, $13; class B concrete in pavement, $4.985; class B concrete in structures, $10; Class C concrete, $9; reinforcing steel, 5c.; a total of $45,069.50. An alternate bid on a wider pavement of macadam was 58½c. per sq. yd., giving a total of $52,825.50.——B. R. Davisson Construction Co. was low bidder and was awarded contract for grading 13 miles of route No. 18 at the following unit prices: excavation, 53c.; class A concrete, $13; class B concrete, $10; class C concrete, $9; reinforcing steel, 5c.; disintegrated granite surfacing, 27c.; a total of $12,596.50.

SACRAMENTO—Holland Construction Co., San Diego, was low bidder at $15,600 and will probably be awarded the contract for construction of reinforced concrete bridge over Myers creek in Imperial county. Other bidders were Robert Sherer & Co., Los Angeles, $28,748; Mercereau Bridge & Construction Co., Los Angeles, $31,513; Forest City Paving & Construction Co., Live Oak, $17,885; Munoz & Munoz, Los Angeles, $32,933.——Contract for construction of State highway in Placer county between Lincoln and Bear River has been awarded to C. H. and A. W. Gorrill, Call Bdg., San Francisco.——State Highway Commission will receive bids until 2 p.m., December 6, for construction of concrete highway in Imperial county from El Centro to Dixieland, about 12 miles. Work includes 47,300 cu. yd. excavation without classification, 11,610 cu. yd. class B concrete in pavement, together with concrete and corrugated-pipe culverts. Plans at office of Commission or at office of Division Engineers in San Francisco and Los Angeles. Plans may be obtained from the office of the Commission upon payment of $2.34 and cross sections upon payment of $8.37.——State Highway Commission will probably advertise for bids at its next meeting for construction of lateral from Auburn to Penryn.——All bids for construction of concrete bridge over Arcade creek have been rejected and work will be re-advertised, calling for bids with and without a fill.——Contract for improvement of M street has been awarded to Clark & Henery Construction Co.——Contract for construction of one mile of concrete roadway on Marysville road will probably be awarded to Wrightson, Anderson & Yost for $2.90 per cu. yd.——Contract for construction of bridge over canal at Folsom has been awarded to C. E. Hodson for $2800.——Residents of Carmichael Colony are considering plans for formation of irrigation district containing 3100 acres. Three plans are proposed, ranging in cost from $52,250 to $115,341. Albert Givan is engineer.——J. W. Terrell was low bidder at $3325 and will probably be awarded contract for erection of transformer station at sewage-pumping plant.——Plans for Hall of Justice have been adopted and bids will soon be called for. Shea & Lofquist, 742 Market street, San Francisco, are architects. Estimated cost is $208,000.——Barton & Hite have been awarded contract for construction of Catholic church. Estimated cost is $20,000.—Trustees of Carnegie library have accepted designs of L. P. Rixford, Sharon Bdg., for building. Estimated cost is $100,000.——Contract for construction of cottages at State School for Girls, near Ventura, has been awarded to Kling Co., 1613 East 15th street, Los Angeles, for $43,333.——Contract for furnishing electric motors to San Quentin prison has been awarded to General Electric Co. for $5700.90.

SALINAS—Board of Supervisors will receive bids until December 6 for grading and macadamizing Monterey-Castroville road, 15 miles. H. F. Cozzens is county surveyor.

SAN BRUNO—Bonds for $20,000 for construction of school building have been voted.

SAN DIEGO—Contract for paving M street has been awarded to California-Arizona Construction Co., 1700 East Washington street, Los Angeles, for 15c. per sq. ft., or a total of $4307.——O. Nelson was low bidder for improvement of Cypress avenue at $44c. per cu. yd. for excavation, 12c. per sq. ft. for sidewalks, and 85c. per sq. ft. for gutters.——Contract for furnishing steel bands for repairing Dulzura pipe-line has been awarded to Pacific Tank & Pipe Co., San Francisco, for $4761.——Contract for completion of Ocean Beach sewer has been awarded to Doran & Armstrong for $48,799.——Contract for construction of reinforced concrete bridge across San Elijo lagoon on State highway has been awarded to H. C. Sparks for $7380.——City manager F. M. Lockwood has recommended addition of chlorination apparatus and aerating table to city filtration plant. Estimated cost is $10,000.——City engineer George Cromwell has prepared plans for 24-in. cement pipe for draining tide-lands from Grape Street canyon. Estimated cost is $1870.

SAN FRANCISCO—Following street work has been ordered: sewers and pavement on Alison street; estimated cost $14,200; curbs and pavement on Bay View street, estimated cost $11,000; grading and sewers on Ocean View avenue, estimated cost $8165; improving Gates street, estimated cost $3950.——Contracts for paving part of Third street with basalt blocks and for paving Texas and Missouri streets, has been awarded to Fay Improvement Co., Phelan Bdg.——Following street work has been ordered: curbs, sidewalks, and asphalt pavement on Corbett avenue; curbs, catch-basins, culverts, sidewalks, and asphalt pavement on Sansome street; sidewalks on Bosworth street.——Contract for furnishing cement for Hetch-Hetchy Valley work has been awarded to Santa Cruz Portland Cement Co., Crocker Bdg., for $2.67 per bbl. f.o.b. Chinese.——Board of

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State Harbor Commissioners is considering tentative plans for viaduct for foot-passengers across embarcadero. Leo V. Merle, Jr., is secretary.——Pacific Gas & Electric Co. has been authorized by the Railroad Commission to issue $12,500,000 in preferred stock. Of this amount, $1,477,500 will be used for various purposes, and the remainder for extensions and improvements to system.——Contract for furnishing 2000 cu. yd. clay for Lincoln Park has been awarded to Owen McHugh, Russ Bdg., for 62½c. per cubic yard.——All bids for construction of sidewalks on Noe Street hill have been rejected.

SAN JOSE—Bids will be received until 11 a.m., December 6, by H. A. Pfister, county clerk, for construction of reinforced concrete revetment and curtain-wall on Los Gatos creek near town of Campbell.——Bids will be received until 11 a.m., December 8, by H. A. Pfister, county clerk, for construction of concrete culvert on Edmonston avenue near Morgan Hill.——Contract for furnishing crushed rock on Kennedy, Roberts, and San Tomas Aquino road has been awarded to George H. Yocco, Los Gatos, for $1.30 per cu. yd.——Contract for furnishing crushed rock on Bryant street, California avenue, and Ashby avenue has been awarded to Thomas Cardoza for $1.12 per cu. yd.——Contract for improvement of several streets has been awarded to J. W. McDonald, Jr.——Contract for improvement of street crossings on 17th street has been awarded to Bert J. Hardiman for 25c. per sq. ft.——Contract for furnishing lumber for bridge over Coyote creek in East San Jose has been awarded to San Jose Lumber Co.——Contract for improvements at Allen school has been awarded to M. Montoya at 8c. per sq. ft. for sidewalks and 40c. per lin. ft. for curbs and gutters.——Contract for laying topeka specification pavement on Lincoln avenue has been awarded to Raisch Improvement Co., Crocker Bdg., San Francisco, for $14,340. Engineer's estimate was $17,050.——Contract for construction of reinforced concrete bridge on New avenue has been awarded to F. F. Moore for $2295.——Contract for construction of pavement on New avenue has been awarded to James Bell and F. Rice for $4287.——Contracts for reconstruction of Market street electric tower have been awarded as follows: for concrete corner posts to Lyden & Bickel for $942; for steel structure to Golden Gate Iron Works, 1541 Howard street, San Francisco, for $5247.——Contract for construction of concrete curtain-wall for Canoas creek dam has been awarded to John Doyle for $1462.——North First Street Improvement Association has adopted design for electroliers submitted by Pacific States Electric Co., 575 Mission street, San Francisco.

SANTA BARBARA—Contract for construction of 100-ft. steel span across Dos Pueblos creek on State highway has been awarded to Security Construction Co., 38th and Alameda streets, Los Angeles, for $9720.——Contract for construction of reinforced concrete bridge with concrete retaining walls across Eagle Canyon creek on State highway has been awarded to Boardman Construction Co., 1107 Story Bdg., Los Angeles, for $10,961.——Contract for paving Booth Point road has been awarded to F. R. Ritchie & Co., Chronicle Bdg., San Francisco, for $16,480.——Contract for construction of concrete sidewalks on West boulevard has been awarded to Munoz & Munoz, Central Bdg., Los Angeles, for 12.5c. per square foot.

SANTA CLARA—Mass-meeting of citizens has recommended bond issue of $40,000 for construction of asphalt pavement on concrete base on several streets. Henry B. Fisher, San Jose, is city engineer.

SANTA CRUZ—Contract for furnishing cast-iron pipe has been awarded to United States Pipe Co., at $36.60 per ton for ordinary pipe and $60 for specials.——Following bids have been received for construction of bridge over Pajaro river at Chittenden: Midland Bridge Co., $6336 for material and construction; Ralston Iron Works, San Francisco, $5170 for material; Dyer Bros., San Francisco, $4200 for material; Clinton Bridge & Iron Works, San Francisco, $4094 for material; Security Construction Co., $5654 for material and construction.——City council has decided against calling election to vote on purchase of Hihn water system.

SAUSALITO—Contract for sewer work in district F has been awarded to Heafey & Tobin, 735 Filbert street, Oakland, at the following unit prices: 6-in. vitrified pipe, $0.70; 6-in. vitrified pipe in concrete, $2.75; 8-in. pipe in concrete, $2.90; 10-in. pipe in concrete, $3; 6-in. class A cast-iron pipe, $2; 12-in. flexible-joint cast-iron pipe, $5; 8-in. lamp-holes, cast-iron frame and cover and terra cotta cap and tee, $15; 6-in. wyes, $0.30; brick man-holes with concrete base, vitrified channels, cast-iron frame, cover and dust-pan, $50; a total of $11,026.30. Engineer's estimate was $11,458.10.——Contract for improvement of West and Valley streets has been awarded to Construction & Engineering Co., 1047-9 Folsom street, San Francisco, at the following unit prices: excavation, 72c.; concrete, $13.70; steel, 3½c.; 30-in. vitrified pipe, $3.60; highway bridge 100 ft. long, $643; a total of $1859.79.

SONORA—App, Dutch, and Sweeney mines have been purchased by W. J. Loring, % Plymouth Cons. Gold Mines, Ltd., Plymouth, California, who will develop mines on a large scale.

STOCKTON—Contract for laying storm sewers on Lower Sacramento road and in Tuxedo Park has been awarded to W. S. Gause, Oakland, for $6196.04.——J. W. Squires and R. B. Gilmour have been granted a permit to use 160 miner's inches of water from Littlejohn creek for irrigation. A lumber and earth dam 5 ft. high and 35 ft. long on top is to be constructed and a ditch ⅝ of a mile long.——Contract for laying sanitary sewers in Homestead district has been awarded to William F. Edwards, 675-31st street, Oakland, for $27,467.24. Engineer's estimate was $32,843.75.

SUSANVILLE—Board of Supervisors has granted petition for election on formation of Southern Lassen irrigation district, but date will not be set until report of State engineer is received. William Wales, Woodland, is engineer.

TAFT—Plans are being prepared for extension of California Natural Gas Co.'s line from Rio Bravo to Wasco, about ten miles.

TRACY—West Side irrigation district comprising 11,500 acres of land near Tracy and Bethany, was ratified at election. George Parker has been elected assessor and Cornelius Looney, tax-collector. No engineer has been appointed as yet and no definite plans made but it is expected to obtain water by pumping from Old river and that the cost of the work will be $285,000.

VACAVILLE—On advice of R. B. Mathews, engineer for Board of Fire Underwriters, all bids for furnishing fire-engine to city will probably be rejected and new specifications will be prepared calling for engine capable of delivering 750 gallons per minute.——Bentley & Gates have been awarded contract for street improvements.

VENTURA—Contract for construction of road on west side of Ventura river north of Foster Park has been awarded to C. E. Black, for $19,992.19.——Contract for construction of protection-levee for Santa Paula bridge has been awarded to G. S. Mowak, Santa Paula, for $4285.——Contract for construction of Ellsworth Barranca bridge has been awarded to J. P. Hunter, 142 West 62nd street, Los Angeles, for $4836.——Contract for construction of Lewis bridge has been awarded to Edgar T. Wheeler Co., 1038 West 20th street, Los Angeles, for $1870.

VISALIA—Following contracts have been awarded for construction of bridges on State highway between Goshen and Traver: bridges No. 1, 3, and 5, to Parlier Construction Co., Tulare, for $1512, $3355, and $3388; bridge No. 2 to Edgar Noble, Visalia, for $2072; and bridge No. 4, to Manning Bros., Fresno, for $2770.——Contract for grading and paving West Main street has been awarded to Thompson Bros., Fresno, for 15½c. per sq. ft. Contract has also been awarded to Thompson Bros. for construction of 60-ft. reinforced concrete bridge over Mill creek, for $1735.——Contract for construction of Southern Pacific depot has been awarded to E. E. Etherton, Monadnock Bdg., San Francisco, for $9122.——Contract for construction of municipal auditorium has been awarded to Trewhitt & Shields, Fresno, for $33,000.——Board of Supervisors will receive bids until early in December for the construction of the following bridges: 40-ft. concrete bridge near Dinuba, 40-ft. concrete bridge near Orosi, 126-ft. bridge near Portersville. Estimated cost of entire work, $4000. Byron Lovelace is county surveyor.

WADDINGTON—L. J. Stone has been granted a permit by State Water Commission to use three miner's inches of water from Soldiers Cove spring, for mining purposes. A 3-in. pipeline 3500 ft. long will be laid.

WASCO—Election has been called for December 11 to vote on bond issue of $45,000 for construction of school building.

WHITTIER—Contract for construction of hollow-tile lemon packing-house for Murphy Oil Co. has been awarded to E. M. Wheatland, 108 North Greenleaf avenue.

WILLOWS—Contract for construction of four miles of canal from Butte creek westerly for the Western Canal Co., San Francisco, has been awarded to E. H. Cameron and T. W. Harlan.——Plans have been prepared by D. W. Ross for irrigation of lands of Sacramento Valley Irrigation Co. About 200,000 acres are affected. D. C. Cowan and Dr. H. W. Hand are directors of Water Users Association.——Contract for construction of Salt Creek bridge at Newville has been awarded to Cotton Bros., for $6090.——Treasury Department has approved plans of Bliss & Faville, Balboa Bdg., San Francisco, for post-office.

WINTERS—City hall, costing $12,000 will be constructed. Building will be used jointly by city and by Yolo county, and city will pay half of cost.

WOODLAKE—Contract for construction of $30,000 high-school building has been awarded to Philbrick & Colvin, Turlock.

WOODLAND—Trustees have passed resolutions of intention for several blocks of street paving. C. E. Arnold is city engineer.——Contract for construction of pavement has been awarded to Clark & Henery Construction Co., Sacramento, for 11½c. per sq. ft. for work on North College street, and 12.2c.

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per sq. ft. for work on Main and East streets.——Pleasant Prairie Ditch Co. has been incorporated to build lateral ditch costing about $1500. Lou Ulrich is interested.——Supervisors of Yolo county and State Reclamation Board have agreed on construction of bridge across Sycamore slough. A. C. Proctor is county surveyor.

YREKA—Engineers from State Highway Commission will make survey of lateral to Eureka by way of Klamath river.

YUBA CITY—Bids will be received until 11 a.m., December 13, by E. T. Barrett, secretary levee district No. 1 of Sutter county, for the purchase of dredge 'Sutter.' Dredge has 150-ft. boom and 3-yd. bucket.

OREGON

BAKER—Contract for construction of three miles of irrigation ditch for Cranston & Ingalls has been awarded to Macy Bros., Sparta.——Bonds for $125,000 for construction of high-school have been voted.

CORVALLIS—Contract for construction of sewers on Orchard street has been awarded to Soleim & Parsons, Springfield, at the following unit prices: 6-in. pipe, 28c.; 8-in. pipe, 35c.; 10-in. pipe, 63c.; 6 by 6-in. tees, 70c.; 6 by 10-in. tees, $1.10; 6 by 10-in. wyes, 60c.; 6 by 8-in. wyes, 50c.; 6 by 6-in. crosses, $1.25; 6-in. 45-degree bends, 55c.; inlets, $10.20; lampholes, $6.50; manholes, $34.50; a total of $926.75. The average cut for the 10-in. pipe is nine feet and for the 8-in. four feet. Other bidders were Abraham & Haddid, $1021.20; John Keating, Portland, $1302.90; A. E. Finley, Salem, $1312.28; C. M. Swartley, $1042.45; John W. Ash, $1072.73.

CULVER—Plans are being prepared for formation of irrigation district in this vicinity.

ENTERPRISE—Contract for construction of 25,600 lin. ft. of lateral sewers has been awarded to James Kennedy Portland, for $18,652.60.

GRANTS PASS—Wesley B. Sherman has been granted permit by State Engineering Department for appropriation of water from Graves creek and from Jump-Off Joe creek for irrigation and power purposes. Estimated cost for project is $1,000,000. Work will include one dam 106 ft. high and one dam 183 ft. high.

HOOD RIVER—Road to base of Mt. Hood is proposed. Length is 7½ miles and estimated cost is $3500. W. A. Furrow is county roadmaster.——Contract for construction of headgates and 7½ miles of lateral ditches for Hood River irrigation district has been awarded to Central Timber & Contract Co., Carlton, for $6700.

LAPINE—Pringle Falls Water & Power Co. has been sold to a syndicate in which F. W. Tomes is interested. A power-plant is nearly completed. Plans of the syndicate include the construction of a vitrified-brick plant, the irrigation of 30,000 acres within three years, and the ultimate irrigation of 250,000 acres.

MARSHFIELD—Contract for construction of concrete sidewalks and curbs has been awarded to Dean & Webber North Bend, for $1.17 per sq. yd. for sidewalks and 37½c. per lin. ft. for curbs.

MEDFORD—Bond issue of $1,030,000 for refunding paving bonds has been defeated.

MILWAUKIE—Plans and specifications prepared by city engineer Morris for water-system have been approved and work will soon be advertised. Estimated cost is $24,000.

PORTLAND—Contract for bitulithic pavement on Alberty street has been awarded to Oskar Huber, Electric Bdg., for $6714.35.——Plans are being prepared for improvement of Union avenue, including fill and viaduct over railroad and paving of roadway. P. H. Dater is city engineer.——Roadmaster John B. Yeon has reported in favor of expenditure of $588,000 for improvement and maintenance of Multnomah county roads; $231,000 of this is for new work.——Oregon-Washington Railroad & Navigation Co. will spend $500,000 reducing grade and curvature on 36 miles of line between Blalocks and Coyote.——Directors of Oregon-Washington Railroad & Navigation Co. have authorized expenditure of $800,000 for rail renewals. Work will be done by company forces.——Robert E. Strahorn, president of Oregon, California & Eastern railway, has started on tour of inspection of country through which road is to run. Reclamation work is also proposed.——Contract for $30,000 reinforced concrete building for Crown-Willamette Paper Co. at Camas has been awarded to Van Sant-Houghton Co., 503 Market street, San Francisco.——Advisory board has recommended the appropriation of $401,000 for construction and maintenance of highways in Multnomah county.

SALEM—Reorganization of Central Oregon Irrigation Company's project is proposed. Plan is to form land affected by project, about 210,000 acres into irrigation district. O. Laurgaard, Railway Exchange Bdg., Portland, is engineer.——State Highway Department is preparing plans for 360-ft. reinforced concrete bridge over Cozine creek near McMinnville.

WARRENTON—Voters have authorized the expenditure of $25,000 for highway work.

WASHINGTON

BELLINGHAM—McCoy-Loggie Timber Co. will build four miles of logging railroad in spring, extending from Welcome on Chicago, Milwaukee & St. Paul railroad. George W. Loggie is president.

CENTRALIA—Construction of highway to Mendota is proposed. Estimated cost is $10,000. County commissioner George Miller in interested.

COLVILLE—Contract for construction of 3½ miles of permanent highway No. 2 between Springdale and Hunters has been awarded to Spokane Asphalt Macadam Paving Co., Spokane, for $10,000.

ELLENSBURG—Cascade Lumber Co. will construct logging railroad 14 miles long from Teanaway on Northern Pacific railroad.

EVERETT—Election to vote on bond issue of $1,800,000 for construction of county highway system has been postponed until December 14.

KENNEWICK—Irrigation project covering 200,000 acres in Benton county is proposed. J. J. Rudkin, manager of the Northern Pacific Irrigation Co., is interested.——Plans have been completed for highway between Richland and Kiona, 10 miles. Estimated cost is $30,000. Work will be advertised soon.

ODESSA—Construction of road to Harrington is proposed. George N. Lowe, Lamona, is interested.

OLYMPIA—State Highway Commission will start surveys after January 1 on State highways to be constructed during 1916. Estimated cost is $150,000.

SEATTLE—Contract for paving Meridian avenue and other streets has been awarded to P. J. McHugh Paving Co., 3rd and Mercer streets, for $21,075.——Contract for paving 47th avenue and other streets has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., for $26,685.50.——Contract for surfacing streets at Issaquah has been awarded to George Banderet, for $7199.——State Highway Department has approved plans for permanent highway No. 12 near Enumclaw.——Plans are being prepared for grading and graveling another road near Enumclaw.——Contract for construction of water-mains on 13th avenue has been awarded to D. Parisi Co., 1506 16th avenue South, for $2703.——Contract for sewers on 48th street has been awarded to D. Parisi Co., for $9531.35.——Contract for construction of Judd Creek trestle on Vashon island has been awarded to P. Manson, for $3340.——A. W. Gould, American Bank Bdg., is preparing plans for 12-story reinforced concrete building for Arctic Club. Estimated cost is $400,000.——Contract for construction of home economics buildings at University of Washington has been awarded to Finn & Gjarde, Northern Bank Bdg., for $99,936.——Contract for grading and concrete walks on Ferdinand street has been awarded to Rowen & Anderson, 504 Transportation Bdg., for $11,676.——American Can Co. is considering construction of plant that will cost $600,000.——Port of Seattle Commission is preparing plans for belt-line railroad, skirting shore of Salmon bay and Lake Union. Estimated cost is $233,000.——Port Commissioners will receive bids until 1:30 p.m., December 15, for furnishing and installing compressors, condensers, fans, ice-making machinery, motors, and other electrical equipment for apple-storage warehouse at foot of Whatcom avenue. Estimated cost is $100,000.——City bridge engineer Rapp has completed plans for bridge over Lake Washington canal at 10th avenue. Estimated cost is $500,000.——Bids will soon be advertised for construction of concrete seawall on Railroad avenue. Estimated cost is $50,000.

SPOKANE—Lawrence F. Connolly, Exchange National Bank Bdg., will construct 14-in. pipe-line, three miles long from St. Maries river to placer ground on Tyson creek. Pumping plant operating against 200-ft. head will be installed.——Kootenai Hydraulic Mining & Power Co. will build four-mile flume to placer ground near Troy, Montana. Estimated cost is $50,000. H. Thompson, Bonners Ferry, Idaho, is interested.——Deer Trail Mining & Development Co. will spend $20,000 on development work, including construction of mill having capacity of 100 tons. Alex Robinson, Victoria Hotel, is manager.

STEVENSON—Contract for construction of road to Cooks has been awarded to J. M. Ambrose, Multnomah Club, Portland, Oregon, for $48,000.——Bids will be received until December 6 by Charles H. Neller, county auditor, for construction of two-span bridge across Wind river on Stevenson-Collins section of State road No. 8.

TACOMA—Contract for construction of concrete viaduct at Custer has been awarded to Mattson & Carlson, for $1990.52.——Plans are being considered for an extension of the Mt. Tacoma road to connect with the Yakima road at Chinook pass, about 30 miles.

WINLOCK—Contract for paving main road from town has been awarded to W. F. Meisner, Transportation Bdg., Seattle, for $2065.

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Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

AMERICAN ASSOCIATION OF ENGINEERS. First convention, Chicago, December 10 and 11. Arthur Kneisel, 29 South La Salle street, Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Winter meeting, Baltimore, Maryland, January 12-15, 1916. J. C. Olsen, secretary, Cooper Union, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION. Annual Convention, Pittsburg, Pennsylvania, February 22-25. E. L. Powers, secretary, 150 Nassau street, New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Annual meeting, New York, December 7-10. Calvin S. Rice, secretary, 29 West 39th street, New York.

ASSOCIATION OF PORTLAND CEMENT MANUFACTURERS. Annual meeting, New York, December 13-15. Percy H. Wilson, secretary, Bellevue Court Bdg., Philadelphia.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING. Chicago, Illinois, February 15-18. J. P. Beck, secretary, 208 South La Salle street, Chicago, Illinois.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS. Annual meeting, Billings, Montana, January 17-19. Carl C. Widener, secretary, Bozeman.

NATIONAL LIME MANUFACTURERS' ASSOCIATION. Annual meeting, Cleveland, Ohio, first week in February, 1916.

Personal

CARL A. EWALD has been appointed a member of the Seattle port commission, succeeding H. M. CHITTENDEN, resigned.

HARRY CAUTHARDFI has been appointed chief engineer for the Western Canal Co., with headquarters at Chico, California.

SHIRLEY HOUGHTON, of Van Sant-Houghton Co., of San Francisco and Denver, has gone to Chicago on a business trip.

L. D. KELSEY has been appointed engineer in charge of the construction of the new $400,000 water-system of Aberdeen, Washington.

J. A. POLLARD, of the United States Bureau of Mines, has resigned to enter the oil-well supply business in California, with headquarters probably in Los Angeles.

GEORGE H. BINKLEY, engineer of maintenance of way and structures for the San Francisco-Oakland Terminal Railways, has resigned.

CARL H. REEVES has opened offices as a consulting engineer at 444 Henry Bdg., Seattle. He will specialize in municipal and highway work.

R. E. KOON, of Portland, Oregon, is in charge of surveys for the proposed water-system for Everett, Washington, representing Burns & McDonnell, of Kansas City.

ALLEN HAZEN and LEONARD METCALF have been in San Francisco during the past month, testifying regarding the value of the property of the Spring Valley Water Company.

R. P. SCHWERIN, formerly general manager for the Pacific Mail Steamship Co., has been appointed vice-president and general manager for the Associated Oil Company.

E. F. CYKLER has gone to Honolulu as chief engineer for the Lord-Young Engineering Co., Ltd. He is to have charge of several large pier-construction and dredging contracts.

J. B. LIPPINCOTT has been retained as consulting engineer by the city of Santa Monica to report on the plans for the storm-water drainage-system which has been proposed for that city.

B. L. BURRELL, of the United States Bureau of Public Roads, has been directed to make an investigation of the proposed highway from San Diego *via* El Paso, Texas, to Washington.

GUY A. HART, junior United States drainage engineer for the western division, has been in Huntington, Oregon, superintending the installation of an experimental cement-tile drainage-system.

R. M. MORTON, who was engineer for the San Joaquin County highway commission during the construction of the highway system of that county, has been appointed engineer for Sacramento County highway commission.

JOHN T. WHISTLER, of Portland, Oregon, has been appointed consulting engineer for International Boundary Waterways Commission, which has been formed to settle disputes over waterways along the Canadian border.

SAMUEL MURRAY, formerly bridge engineer for the Oregon-Washington Railroad & Navigation Co., has been appointed chief engineer of that company, succeeding J. R. Holman, who retired recently on account of ill-health.

HARVEY W. HICKS, assistant engineer for the United States Indian Irrigation Service, has been made engineer for the Service, with headquarters at Chiloquin, Oregon, where he is in charge of irrigation work on the Klamath Indian Reservation.

EDWARD S. SMITH, formerly state highway engineer of Idaho, has been appointed chief engineer for the proposed Yellowstone Park highway. This road will be about 60 miles long and will be constructed jointly by the United States Forest Service and by the State of Idaho. Construction will be commenced next spring as early as the weather will permit.

Catalogues Received

'ARMCO' IRON RUST-RESISTING PRODUCTS. The American Rolling Mill Co., Middletown, Ohio. P. 64. Illustrated. Describes a number of the rust-resisting products of the company, ranging from corrugated roofing to metal lath.

THE RICHARDSON MODEL M SIGHT-FEED OIL-PUMP. The Richardson Phenix Co., Milwaukee, Wisconsin. P. 20. Illustrated. Describes the manufacture and use of this lubricating device, special attention being paid to gas-engine lubrication.

THE PHENIX FORCE-FEED LUBRICATOR. The Richardson Phenix Co., Milwaukee, Wisconsin. P. 12. Illustrated. Describes the Phenix ratchet-type lubricator. The amount of oil fed varies directly with the speed of the machine, insuring economy and good lubrication.

LINE MATERIAL AND RAIL BONDS FOR MINE AND INDUSTRIAL HAULAGE. *Bulletin* No. 44005. The General Electric Co., Schenectady, New York. P. 76. Illustrated. Describes the equipment manufactured by the company, and gives a number of useful tables for calculating sizes required, etc.

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